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# The Assessment Of The Usability Of The Vestibular Rehabilitation Application

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**THE ASSESSMENT OF THE USABILITY OF THE VESTIBULAR  
REHABILITATION APPLICATION**

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A dissertation submitted in partial fulfillment of the requirements for the degree of MSc  
in Neurology and Gerontology

School of Physiotherapy.

Faculty of Health Sciences,

Royal College of Surgeons Ireland,

September 2016

Research Supervisor: Dara Meldrum

## **DECLARATION**

I declare that this thesis, which I submit to RCSI for examination in consideration of the award of a higher degree in Neurology and Gerontology is my own personal effort. Where any of the content presented is the result of input or data from a related collaborative research programme this is duly acknowledged in the text such that it is possible to ascertain how much of the work is my own. I have not already obtained a degree in RCSI or elsewhere on the basis of this work. Furthermore, I took reasonable care to ensure that the work is original, and, to the best of my knowledge, does not breach copyright law, and has not been taken from other sources except where such work has been cited and acknowledged within the text

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RCSI Student Number: 14117282

Date: 10/09/2016

## **SUMMARY**

### **Introduction**

Vestibular rehabilitation is used for decreased vestibular function and dizziness. Adaptation exercises are one aspect of vestibular rehabilitation and are recommended in the treatment of these conditions. These exercises are predominantly paper-based which may lead to difficulty in progression of the exercises and monitoring of compliance.

### **Aims and Objectives**

The aim of the study was to assess the usability of an electronic tablet application; the Vestibular Rehabilitation Application (VRA) in patients with a complaint of dizziness who were undergoing vestibular rehabilitation.

The objectives of the study were to assess usability under three main headings of effectiveness, efficiency and satisfaction as recommended by the International Standardisation Organisation (ISO) in 1998

### **Methods**

A convenience sample (n=12) was recruited. Baseline assessments included age, Dynamic Visual Acuity Test, level of education, Dizziness Handicap Inventory, Visual Analogue Scale for dizziness and the length of time it took the participant to be trained up on the use of the tablet and VRA. The participant used the VRA for one week and then completed the System Usability Scale (SUS) and the Systems Usability Measurement Inventory (SUMI) along with a semi structured interview

## **Results**

The length of time to train the participant, previous use of apps and age were the biggest predictors of usability. There were no correlations with usability and levels of dizziness. Participants noted decreased effectiveness and efficiency in their use of the app but would use the VRA in future rehabilitation.

## **Conclusions**

This study suggests that training time, previous use of apps and age are the biggest predictors of usability.

## **Implications of Findings**

The VRA was deemed as “usable” however there should be some changes to the app before further use in treatment.

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## **List of Abbreviations**

App = Application

BPPV = Benign Paroxysmal Positional Vertigo

CSO = Central Statistics Office

DHI = Dizziness Handicap Inventory

DVAT = Dynamic Visual Acuity Test

ETDRS = Early Treatment Diabetic Retinopathy Study

ISO = International Standardisation Organisation

MoCA = Montreal Cognitive Assessment

NFQ = National Framework of Qualifications

PI = Principal Investigator

r = Pearson Product Moment test

SD = Standard Deviation

SPSS = International Business Machines Statistical Package Version 22

SUMI = System Usability Measurement Inventory

SUS = System Usability Scale

UCC = University College Cork

VAS = Visual Analogue Scale

VOR = Vestibulo-Ocular Reflex

VRA = Vestibular Rehabilitation Application

X1 = time's one (adaptation exercises)

X2 = time's two (adaptation exercises)

X3 = time's three (adaptation exercises)

$\rho$  = Spearman's Rank Correlation test

## **INTRODUCTION**

### **Vestibular Rehabilitation**

Vestibular rehabilitation is a relatively new area in physiotherapy with current best practice based on literature published in the 1990s. Adaptation exercises are recommended for those with decreased dynamic visual acuity and involve the patient maintaining visual fixation on a target while moving his or her head horizontally or vertically. There are three levels of these exercises however further progression on paper-based adaptation exercises is difficult.

Both natural age-related declines in vestibular function and pathological loss of vestibular function result in symptoms of dizziness and increased risk of falls in the elderly (Hall et al, 2010). However these adaptation exercises improve falls risk in the elderly along with subjective measures of balance and dizziness (Hall et al, 2010; Brown et al, 2006).

### **Use of Technology**

There is rising ownership of smartphones and tablets in Ireland (Eircom, 2015) therefore it is imperative that physiotherapy incorporates technology in its rehabilitation. Although the ownership of technology is ever-increasing, technology use among elderly adults is still low with technological use in rehabilitation very low (Sum et al, 2009). With over 65s at an increased risk of vestibular dysfunction due to age related decrements, it is important to understand whether or not technology can be used in this population for vestibular rehabilitation.

## **Vestibular Rehabilitation Application (VRA)**

The VRA was developed by a computer scientist and a physiotherapist. It aims to provide adaptation exercises through an application (app) on an electronic tablet. This allows the patient to focus on the exercise without counting the time as the VRA has an inbuilt timer. It also allows the patient to further challenge and therefore progress their adaptation exercises by incorporating moving backgrounds and optokinetic stimulation as recommended by Rossi-Izquierdo et al (2011). The VRA also allows the therapist to compare reported levels of compliance with actual levels with the diary format on the app.

## **Usability**

Hart et al (2008) evaluated websites designed for older adults in terms of how well they adhere to 'senior-friendly' guidelines ([www.nihseniorhealth.gov/](http://www.nihseniorhealth.gov/)) and overall ease of use and satisfaction. The study found that the website most compliant with the 'senior-friendly' guidelines resulted in higher task success, but did not result in significantly better efficiency, satisfaction, or preference. These findings demonstrate the importance of using both guidelines and usability testing when designing websites for older adults. There would be little point in prescribing an exercise that a patient found impossible to complete. Adherence would decrease resulting in decreased effectiveness of the exercise. As the VRA is a relatively new format of exercise prescription, it is imperative that usability is tested firstly to allow each patient every opportunity to use the app effectively.

## **CHAPTER 1: LITERATURE REVIEW**

### **1.1 Dizziness and Gaze Instability**

Cherchi (2013) reported on the difficulties of calculating the epidemiology of dizziness in the general population due to the varying descriptions and causes of dizziness. However Karatas (2008) calculated the incidence of central dizziness in the general population as between 20 and 30%. In Ireland alone, this figure equated to 1.37 million people in 2011 (CSO, 2011). Dizziness or vertigo accounted for 2.5% of all emergency department visits in United States between 1995 and 2004 (Kerber et al, 2008) yet patients who complained of dizziness were not routinely screened for vestibular involvement (Kroenke and Mangelsdorf, 1989). This suggests that services are limited and a more detailed vestibular assessment and treatment are required.

Dizziness is usually caused by a disturbance of the sensory modalities or cardiovascular complications. These sensory modalities include vision, vestibular input, joint position, touch and hearing and allow perception of the body's movement and position in space (Mukherjee et al, 2003). There are many different descriptions of dizziness and differentiating between these can often help with the diagnosis (Karatas, 2008). The systematic review by Hansson (2007) defined several forms of dizziness, proving that dizziness is a non-specific term that describes many sensations. This review was not well conducted as it lacked a clearly focused question and did not assess the quality of the studies included. However it gave a useful overview of the various types of dizziness. The various forms of dizziness included a multisensory cause where the patient felt unsteady and unbalanced, vertigo which involved a feeling of rotation often coupled with nausea, presyncope which was a sensation of a fall about to happen and

lightheadedness, which Hansson (2007) admitted was a vague description that was difficult to define.

Descriptions of dizziness can often be difficult to determine during assessment. Chan (2009) suggested that therapists should ask the patient to describe their symptoms without using the word “dizzy”. However Newman-Toker et al (2007) found that descriptions of dizziness were inconsistent in 52% of emergency department patients with dizziness. These patients had inconsistent responses to choosing the best single descriptor of dizziness on initial testing and retesting about six minutes later. Despite these vague initial descriptions, most patients can still be categorized as having vertigo, presyncope (lightheadedness) or disequilibrium.

For the purpose of this dissertation, all forms of dizziness were included except for Benign Paroxysmal Positional Vertigo (BPPV). The main criterion for inclusion was decreased dynamic visual acuity as measured on the Dynamic Visual Acuity Test (DVAT).

Gaze instability is often coupled with dizziness in neurological and inner ear diseases (Strupp and Brandt, 2013) and aging (Marchetti et al, 2011). Gaze instability is also known as oscillopsia and can be identified when the patient has blurred vision with head movement. Gaze instability in particular is a common symptom in patients with decreased vestibular function (vestibular hypofunction) along with impaired balance and dizziness caused by head movement (Gresty et al, 1977, Chambers et al, 1985, Bhansali et al, 1993).

The Vestibulo-Ocular Reflex (VOR) maintains stable vision during head movement. Abnormalities in the VOR appear after an acute loss of peripheral



vestibular function. Nystagmus (rhythmical oscillation of the eyes) and tilting of the body away from midline happen when the head does not move, while there is a greater decrease in balance and vision when the head is moved. As a result the patient is less likely to move their head to counteract these symptoms (Hain and Helminski, 2014). After such an injury to the vestibular system, the VOR becomes undercompensatory and is referred to as having a gain of less than one. This means retinal image slip occurs and the patient experiences blurred vision with head movement. Certain components of vestibular rehabilitation focus on improving the VOR compensation through active head movement (Migliaccio and Schubert, 2014).

## **1.2 Vestibular Rehabilitation**

Vestibular rehabilitation began in the 1940s with Cawthorne and Cooksey designing the original vestibular rehabilitation programme for British soldiers injured in the Second World War (Cawthorne, 1945; Cawthorne, 1946; Cawthorne, 1949). Despite the positive outcomes in their programmes, vestibular rehabilitation was not elaborated on until the late 1980s and early 1990s with several authors expanding the discipline (Herdman, 1990; Norré and Beckers, 1988; Odkvist and Odkvist, 1988; Shumway-Cook and Horak, 1990; SmithWheelock et al., 1991). A Cochrane review by McDonnell and Hillier published in 2007 reported moderate to strong evidence for vestibular rehabilitation in unilateral vestibular hypofunction. This was reaffirmed in 2011 and 2015 with further Cochrane reviews by the same authors (McDonnell and Hillier, 2015). Modern research has widened the use of vestibular rehabilitation to patients with other causes of dizziness than peripheral vestibular disorders such neurological conditions and aging (Kammerlind et al 2001).

Vestibular rehabilitation is an exercise-based approach that began with the aim of maximising central nervous system compensation for vestibular pathology (Hoffer and Balaban, 2010). The original exercises by Cooksey and Cawthorne used a class-based setting with progressively difficult exercises to challenge the central nervous system (Cawthorne, 1946). The basis for recovery was habituation where patients became desensitized and accustomed to movements that provoked dizziness.

However Herdman (2000) has since further defined vestibular rehabilitation responses which explain recovery of vestibular function. These include compensation which is based on the plasticity of the central nervous system and uses movement to reduce responsiveness to repetitive stimuli and to re-balance activity in the vestibular nuclei (Gans, 2002). This approach is similar to habituation as described above however; compensation or a neuroplastic process is more likely (Hain, 2011).

Herdman (2000) also described the process of adaptation for visual-vestibular interaction (gaze stabilisation) and possibly eye-hand co-ordination, using repetitive and provocative movements of the head and/or eyes to reduce error and restore VOR gain and improve VOR compensation (Balaban 2012; Cullen 2009).

However vestibular rehabilitation has developed significantly since then. A Cochrane Review in 2015 (McDonnell and Hillier, 2015) reported that current management includes medications, physical manoeuvres and exercise programmes with both manoeuvres and exercises collectively known as vestibular rehabilitation. This was a well conducted systematic review with a clearly focused question, specified inclusion criteria, detailed search strategy, study quality and

reproducible assessments. McDonnell and Hillier (2015) reported that the main components of vestibular rehabilitation include gaze stability (or adaptation) exercises, habituation exercises and postural stability exercises.

Both natural age-related decrements of vestibular function and pathological loss of vestibular function result in symptoms of dizziness and increased fall risk in the elderly (Hall et al, 2010). Herdman et al (2003) found that vestibular exercises facilitated the recovery of gaze stabilisation during predictable head movements and to a certain extent, unpredictable head movements. This study reported that the mechanism for recovery may be adaptation of the VOR from vestibular exercises. Hall et al (2010) showed that gaze stability exercises in the elderly population not only improve perceived disequilibrium, but also decreased their falls risk on the Dynamic Gait Index. Similarly Brown et al (2006) found that vestibular physical therapy improved patients' subjective and objective measures of balance in patients with central vestibular dysfunction.

Three different exercises enhance gaze stability in patients with vestibular hypofunction. The first exercise involves the patient maintaining visual fixation on a target while moving his or her head horizontally or vertically (Adaptation time's one – X1). This exercise can be further progressed (X2) by moving the target and the head in opposite directions. The second exercise involves repeated eye then head movements between two targets, again maintaining visual fixation on the target throughout. The third exercise involves imagining visual fixation on a target during head movement with the eyes closed. The patient checks their acuity by opening their eyes to see if they are maintained fixation on the target. Collectively these exercises are termed gaze stability exercises and are used in vestibular rehabilitation programmes (Herdman and Whitney, 2014).

A number of investigators have documented advantages of adaptation exercises for improving recovery time for vestibular dysfunction (Chen et al, 2012; Cohen, 2006). The gaze stability exercises also have been found to improve postural stability dramatically, even without posture training (Morimoto et al., 2011). Interestingly, optokinetic based therapy (visual fixation with a moving background), produced a significantly better outcome than computerized postural rehabilitation on a number of balance measures (Rossi-Izquierdo et al., 2011). This study compared computerised dynamic posturography to optokinetic stimulation in patients with unilateral vestibular hypofunction over five days. The results showed that exposure to optokinetic based therapy equalises vestibulo-ocular reflex asymmetries thus allowing the central nervous system to correctly resolve any sensory balance conflict and balance would therefore be recovered without directly working on balance re-education. This suggests that incorporating optokinetic stimuli in vestibular rehabilitation is important and would not only have an effect on the patient's VOR but also on their balance.

### **1.3 Electronic Use in Vestibular Rehabilitation**

Laver et al (2013) recently assessed the views of occupational therapists, rehabilitation team members and patients in preferred methods of service provision. The study found that of all rehabilitation team members, occupational therapists were the most enthusiastic about using technology in rehabilitation. The study found that of the 100 patients assessed, their acceptance of technology was low. However the mean age of these subjects was 75 and it is known that older persons find technology less usable (Browne, 2005). Similarly Blit-Cohen and Litwin (2004) also reported from their qualitative study that those over 65 blamed their age and health issues for their inability to use technology while Sum et al

(2009) found that those over 55 did not use technology for exercise or rehabilitation, but rather for gathering information about purchases and keeping in contact with friends and family.

Despite these studies, the use of electronic devices in vestibular rehabilitation is growing. Chen et al (2012) found positive results for the use of a Nintendo Wii remote (Wiimote) for gaze stability exercises in four subjects (aged 40, 62, 67 and 78 years of age) with unilateral and bilateral vestibular hypofunction. After twelve sessions over six weeks using the Wiimote, each of the subjects reported decreased dizziness and improved quality of life. Similarly the DVA improved considerably in each subject as did the Activities-Specific Balance Confidence Scale and Timed Up and Go scores. Huang et al (2014) found that iPods were suitable for home use in vestibular rehabilitation. The authors also noted under-compliance in over half of the participants between reported compliance and that which was recorded on the iPod. Similarly Beom-Chan et al (2012) studied a smartphone that provided real-time vibrotactile feedback about postural sway. Both healthy participants and participants with vestibular dysfunction improved significantly on eyes open and eyes closed balance tasks in antero-posterior sway and medial-lateral sway. The authors also noted that this was a more feasible option of providing postural feedback for the patient at home. Meldrum et al (2015) conducted a randomised controlled trial comparing conventional balance exercises with balance exercises on the Nintendo Wii in a six week vestibular rehabilitation programme in patients with unilateral vestibular loss. While there was no significant difference in outcomes or adherence to exercise, the intervention group using the Nintendo Wii did report higher enjoyment, less difficulty with the exercises and less fatigue after the exercises.

All of the above studies show promising results for technology use in vestibular rehabilitation and the area is continuing to grow in the literature. Geraghty et al (2014) published a protocol for internet-based vestibular rehabilitation in adults aged 50 years and older. This study will be a single blinded randomized controlled trial examining the effectiveness and cost of internet-based vestibular rehabilitation. This may be a feasible option for the majority of patients with internet access. Similarly Migliaccio and Schubert (2014) published the results of a pilot study using a helmet that sensed horizontal angular velocity that generated a visual target that could be set differently for rotation to the left and right. In unilateral vestibular hypofunction, this helmet therefore prevented over-compensation of the VOR on the healthy side. The results were positive but as this was a pilot study with limited detail on study design, further testing is necessary.

Smaerup et al (2015) compared computer-assisted training to printed instructions in home exercise programmes for patients with chronic dizziness. The study was single blinded with randomized group allocation. However the primary outcome measure of one leg stand was not very clearly documented in the study with only improved secondary outcome measures explained. The intervention was also not available for use after the trial suggesting the results cannot be applied in all contexts. The study found no difference between internet-based vestibular rehabilitation and paper based instructions. The study suggested that patients enjoyed the internet-based rehabilitation more than paper based however, evidence of this assessed in the trial was anecdotal.

The patients in this study by Smaerup et al (2015) had an average age of 77 in the intervention group and 79 in the control group. However there was no mention of

usability in the study. Similarly Geraghty et al (2014) published a protocol where they aim to assess if internet-based vestibular rehabilitation decreases cost and dizziness in over 50s. However, there is again no mention of assessing the usability of the internet based rehabilitation tool prior to measuring its effectiveness. The only study to assess usability in vestibular rehabilitation technology was Meldrum et al (2011) where the usability of the Nintendo Wii was examined. The follow up study assessing the effectiveness of the Nintendo Wii (Meldrum et al, 2015) reported higher levels of enjoyment in comparison to Smaerup et al (2015). This would suggest that assessing the usability of an intervention allows for changes to be made prior to assessing the effectiveness of it which overall may improve the patient's experience.

#### **1.4 Use of Applications in Healthcare**

Eircom (2015) recently carried out a survey that showed that 50% of Irish people now own a smartphone equating to 1.6 million people. Similarly the survey predicted that 1.2 million people will have access to a tablet by the end of 2015.

The IMS Institute for Healthcare Informatics (2013) analysed over 40,000 healthcare applications (apps) available for download from the United States Apple iTunes app store and an assessment of the potential value they provide throughout a patient's journey. The report found that applications went predominantly in the overall wellness category, with diet and exercise applications accounting for the majority available. The study also found that most healthcare applications merely provide information.

Similarly PatientView and myhealthapp.net (2015) surveyed 1,130 patients and carers about healthcare apps. The survey found that nearly half of all respondents

were active in trying to improve their health by using electronic facilities. Thirty percent of patients and carers were using health apps as the main way of getting involved with healthcare electronically, to seek information and to network with those in a similar situation. However the survey found that patients and carers wanted to understand their medical condition and treatments along with practical support such as care planning and also wanted to be able to communicate with their doctor or nurse through health apps. The survey also found that patients felt there were too many apps to choose from and were unsure whether the app would provide accurate information.

The responses from 211 different stakeholders to the public consultation on the EU's Green Paper on mHealth (2015) identified seven major areas of concern with mobile health apps that need to be addressed before the technology can go mainstream including the need for clarity on levels of data security to protect public and patients, the lack of appropriate governance of lifestyle (non-medical) health apps, the possible threats to patient safety, the lack of transparency about who lies behind an app, the lack of clinical input and integration with healthcare systems, the lack of clarity about whether health apps produce positive outcomes and the ill-funded nature of the entire enterprise that surrounds app development.

Patients currently face an overwhelming amount of healthcare applications to choose from, with little guidance on quality or support from their medical professionals. It is also clear that applications developed to date do not fit well with the greatest areas of spend in healthcare – those patients facing multiple chronic diseases and typically over the age of 65. These patients are likely to be among the top healthcare spenders but smartphone penetration is lowest among this group, with only 18% of the U.S. population using them, compared to 55% of



those aged 45-54 years (EU Green Paper on mHealth, 2015). This current study aimed at identifying barriers for this population in using an app for exercise.

### **1.5 Vestibular Rehabilitation Application (VRA)**

In a conversation in April 2015 with the principal investigator, D. Meldrum discussed how the development of an electronic application; the Vestibular Rehabilitation Application (VRA) that would aim to provide gaze stability exercises for patients with vertigo and dizziness. The aim of VRA was to replace paper based gaze stability exercises with the same exercises through an app. This would provide instruction and feedback to patients and gather accurate data on the patient's adherence and progress (McNeely, 2015).

The VRA was developed by a physiotherapist and a computer scientist over the course of a year. It contains video demonstrations of each exercise along with written instructions. Recovery of the VOR usually requires approximately four weeks of therapy and there is no evidence of improvement at four weeks in those not receiving therapy (Herdman et al., 2003). The VRA therefore contains six weeks of progressive adaptation exercises with five sets of exercises each day. The exercises are laid out in a diary platform and once an exercise is completed, it is "ticked" off as completed so the user knows which exercises are left to complete. This is also a useful way for the therapist to record patient adherence to the exercises.

In order to provide instant feedback to the patient about correct exercise technique such as correct head velocity and amplitude, a sensor is required. At the time of

this dissertation study however the RFduino Microcontroller sensor was still being developed and was not available for use.

The VRA was also assessed by vestibular therapists through focus groups however the official results were not available at the time of this dissertation study. The results were briefly discussed with D. Meldrum in April 2016 as informal communication and informed how the focus groups provided information on aesthetics, functionality and predicted use. The therapists suggested the insertion of game-based exercises and the ability to decrease or increase the number of exercises and duration of each exercise to make the app more patient-specific.

### **1.6 Definition of Usability**

Usability is defined as “the effectiveness, efficiency, and satisfaction with which specified users can achieve goals in particular environments” (ISO, 1998).

Effectiveness aims to identify how good the subjects are at using the application. Efficiency relates to the amount of effort the application takes from the patient’s perspective and finally satisfaction looks at the user’s comfort with and positive attitude towards the use of the application.

The usability of a new product such as an app should be tested prior to assessing whether the app is superior to other formats of treatment. The ability of the patients to use the application is paramount to the effectiveness of it as an intervention; therefore it is essential to carry out a usability study with this application before it is used as a treatment option. There is little sense in using a treatment technique that the patient cannot understand or use therefore usability testing is an obvious pre-test to measuring effectiveness. Hornbaek (2006) found

that there were several issues with previous usability tests in research, mainly the lack of measures of quality of interaction between the user and the application. Hornbaek (2006) also found that learning and retention are rarely assessed and that most studies use their own questionnaires instead of validated questionnaires.

## **1.7 Conclusion**

There is a high incidence of dizziness in the population and it is known that vestibular rehabilitation is an effective method of treatment, not only for peripheral vestibular disorders, but also for neurological conditions and ageing. With rising ownership of smartphones and tablets, it is imperative that vestibular rehabilitation also moves forward and incorporates technology in its approach. However this approach must be assessed thoroughly before deemed suitable for treatment as the literature is currently lacking in the areas of elderly use of technology and overall usability of health related apps.

Therefore the aim of this study was to investigate usability of the VRA from the patient perspective using the System Usability Scale (SUS-See Appendix 1.1) and the Software Usability Measurement Inventory (SUMI-See Appendix 1.2), two validated measures in assessing user's attitudes to software (Sweeney and Maguire, 1994; Coleman, 1993; Bangor et al, 2008; Lewis and Sauro, 2009) along with an interview to gain insight into participants' experiences of the VRA.

## **CHAPTER 2: METHODOLOGY**

### **2.1 Aims and Objectives**

The aim of the study was to assess the usability of an electronic tablet application; the Vestibular Rehabilitation Application (VRA) in patients with a complaint of dizziness who were undergoing vestibular rehabilitation.

The objectives of the study were to assess usability under three main headings of effectiveness, efficiency and satisfaction as recommended by the International Standardisation Organisation (ISO) in 1998. Effectiveness aimed to identify how good the participants were at using the application. Efficiency studied the amount of effort the application took from the patient's perspective and satisfaction looked at the user's comfort with and positive attitude towards the use of the application. Each of these three subscales was measured through the use of two validated questionnaires; the System Usability Scale (SUS), the Software Usability Measurement Inventory (SUMI) and through one to one interview.

The hypotheses were that there would be a negative correlation between age and usability and also between level of dizziness and usability in that the higher the age and level of dizziness, the lower the usability. It was also hypothesised that the longer the patient's training time, the less usability shown on the app.

### **2.2 Study Design**

This study was an observational cross sectional study with a comparative group; previous use of apps versus those with no previous use of apps.

The study used a mixed methods approach with both quantitative and qualitative components.

### **2.3 Participants**

The population included patients with peripheral and central vestibular dysfunction or patients with a complaint of dizziness. Participants were over 18 years of age with no limit on age.

The sample included those that were referred for vestibular rehabilitation. The sampling method was by convenience and a sample size of at least 12 participants was calculated as necessary to obtain sufficient data on the SUS (Lewis et al 2009) and the paper version of the SUMI (Kirakowski, 1993).

Participants were recruited from the vestibular clinic, the orthopaedic wards, the medical wards and the out-patient and primary care physiotherapy departments in Midlands Regional Hospital, Tullamore. Only patients requiring gaze stability exercises were included in the study. There was no randomisation of the participants. The gatekeepers were an advanced nurse practitioner in the vestibular clinic who tested the patients before referral to physiotherapy and the treating physiotherapist. If the treating physiotherapist was the principal investigator, another physiotherapist acted as gatekeeper.

Inclusion Criteria included:

- Participants referred for vestibular rehabilitation in Midlands Regional Hospital, Tullamore or associated primary care centre
- Participants 18 years or older
- Participants with normal comprehension as judged by their treating physiotherapist and able to follow instruction. If a formal assessment was required, the Montreal Cognitive Assessment (MoCA- See Appendix 2.1) was carried out. Those with a score of 26 or more could participate in the study.

- Participants must have started/currently participate in/completed a vestibular rehabilitation programme and completed at least three reviews with their physiotherapist for adaptation exercises. This ensured that the participant had a clear understanding and familiarity with the adaptation exercises before beginning the study
- Participants with quantified peripheral or central vestibular hypofunction as diagnosed by an audiologist including, but not exhaustive of:
  - Unilateral or bilateral vestibular hypofunction
  - Acoustic neuroma resections
  - Unilateral Meniere's disease
  - Vestibular neuritis
  - Migraine related vestibulopathy and dizziness
  - Multiple Sclerosis
  - Post stroke dizziness

or an ongoing complaint of dizziness with head movement with decreased dynamic visual acuity as demonstrated on the Dynamic Visual Acuity Test (DVAT).

Exclusion criteria were:

- Participants with an active benign paroxysmal positional vertigo (BPPV)
- Participants that were unable to follow instruction or with a MoCA of less than 26. Those with less than 26 were treated with usual vestibular rehabilitation exercises.

## **2.4 Ethical Considerations**

The gatekeepers initially approached the potential participant and described the study to the patient and provided them with the patient invitation letter (Appendix 2.2), patient information leaflet (Appendix 2.3) and consent form (Appendix 2.4). When the patient attended physiotherapy for their vestibular rehabilitation either on the ward or in the out-patient clinic, both written and verbal consent (See Appendix 2.4) was obtained by the PI. It was voluntary to participate in the study and participants had the right to refuse to participate or to drop out without giving reason at any stage during the study. Confidentiality and data storage was followed as per the Data Protection Act (1988). Each participant had their own account on the application, however no personal data was stored on the application and their identity on the application was coded. The PI was the only researcher with access to this code. The baseline assessments and the post testing assessments were initially on paper, again with the participants' identities coded, but were transferred to an electronic common document on Microsoft Word (See Appendix 2.5) and all paper versions were destroyed by the PI. These documents were saved to a password protected electronic folder on the Royal College of Surgeons Ireland fileservers. All data sent to external sources for analysing, such as the SUMI scale, were coded (See Appendix 2.6 for SUMI Ethics Statement).

Permission to approach the participants and recruit them was sought (Appendix 2.7) and obtained (Appendix 2.8) from the Physiotherapy Manager.

Ethical approval was received from the Midlands Research Ethics Committee (REC) in September 2015 (Appendix 2.8 and 2.9) with follow up ethical approval from Royal College of Surgeons Ireland (See Appendix 2.10).

## 2.5 VRA

The VRA was developed by a physiotherapist and a computer scientist and was available for use on android devices. The participants logged in with their coded username and password (See Figure 2.1) and were greeted by the home screen. The home screen (Figure 2.2) showed the participants' level of dizziness (as measured by a visual analogue scale {VAS} after each exercise). Unfortunately, the version of VRA used in this study did not show the correlation between the participants' dizziness and the graph, it was merely for demo purposes.

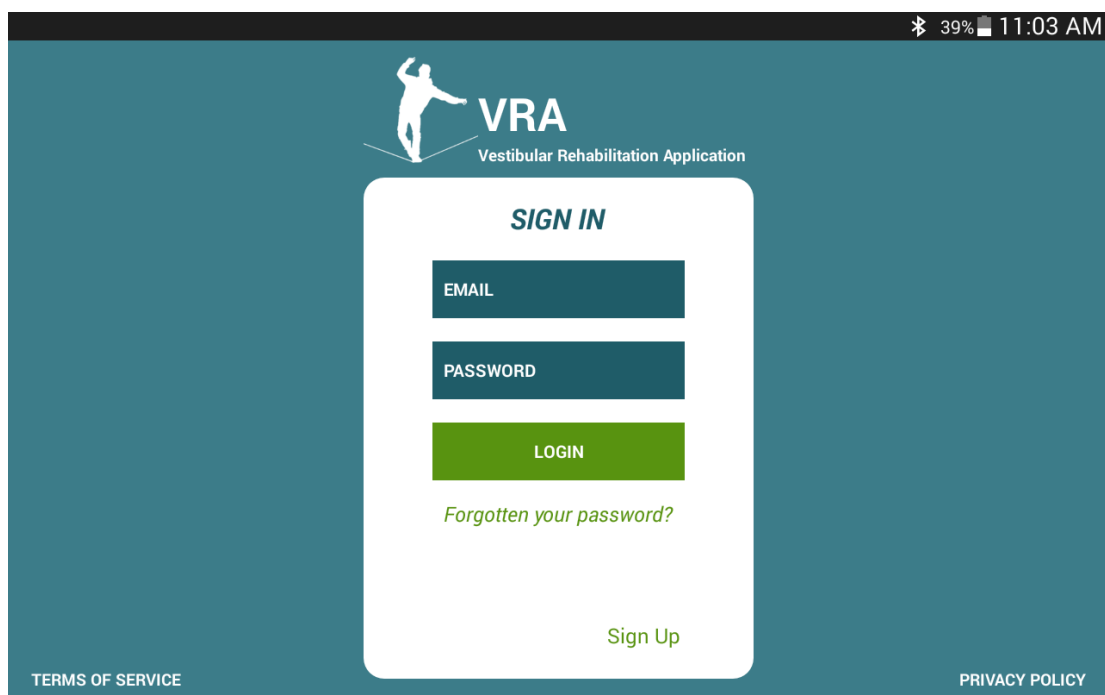


FIGURE 2.1 LOGIN SCREEN



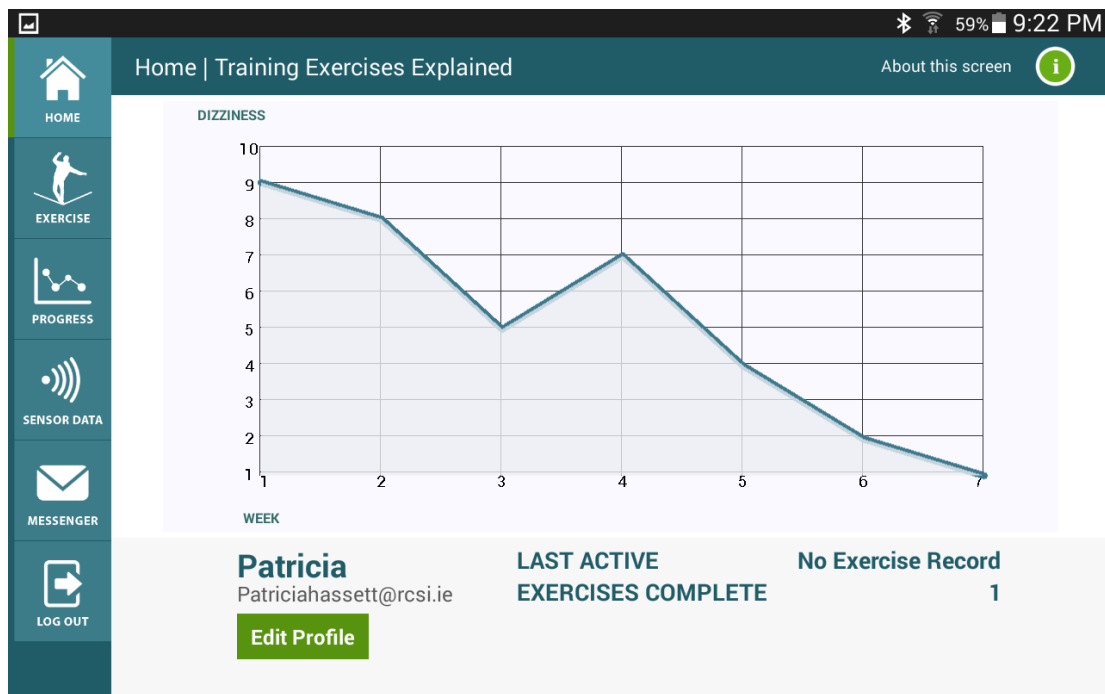


FIGURE 2.2 VRA HOME SCREEN

The exercises were available in a diary format and after completion of each exercise; a tick appeared beside it to confirm completion (Figure 2.3). The participant tapped on the exercise they wished to complete and was met with two instruction screens, one a video demonstration (Figures 2.4 and 2.5). The participant then tapped “Start” and the exercise began (Figure 2.6). Figure 2.6 shows the timer in the bottom right corner which allowed the participant to focus fully on the exercise. At the end of the exercises, a VAS for dizziness appeared allowing the participant to rate their dizziness (Figure 2.7).

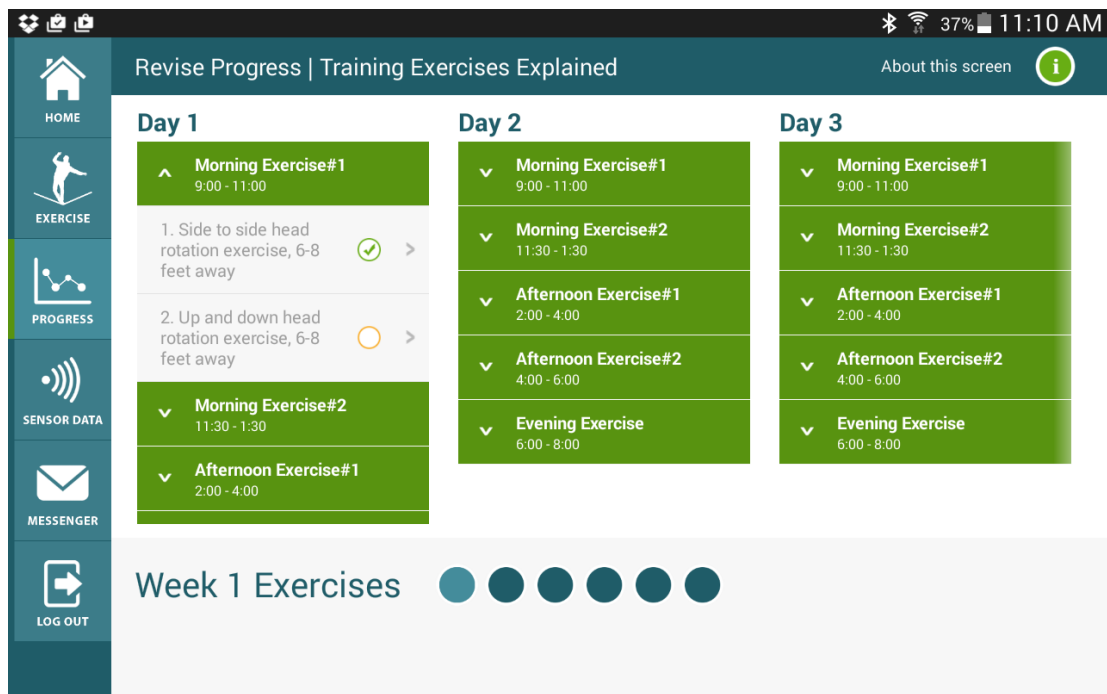


FIGURE 2.3 DIARY FORMAT

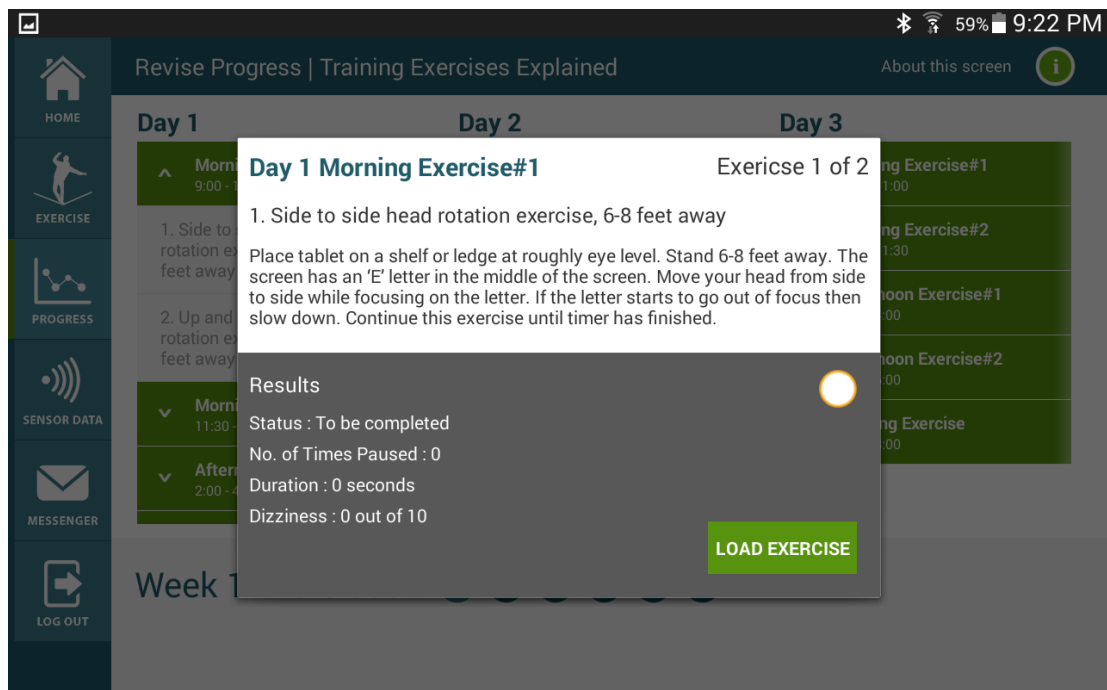


FIGURE 2.4 INSTRUCTION SCREEN

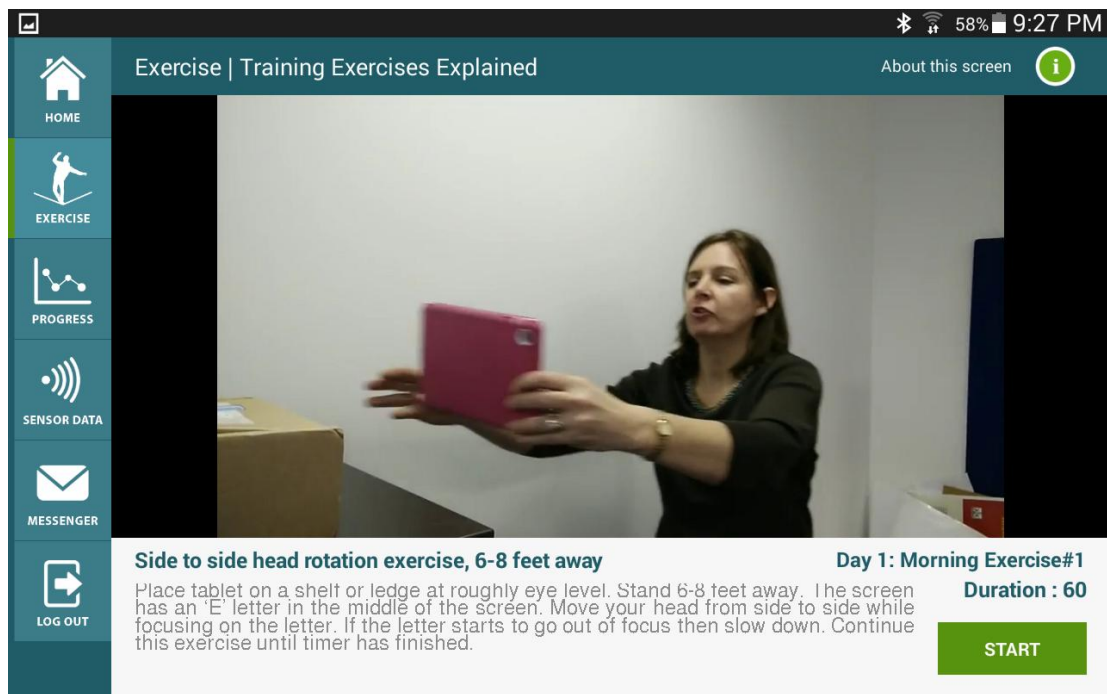


FIGURE 2.5 VIDEO DEMONSTRATION OF EXERCISE

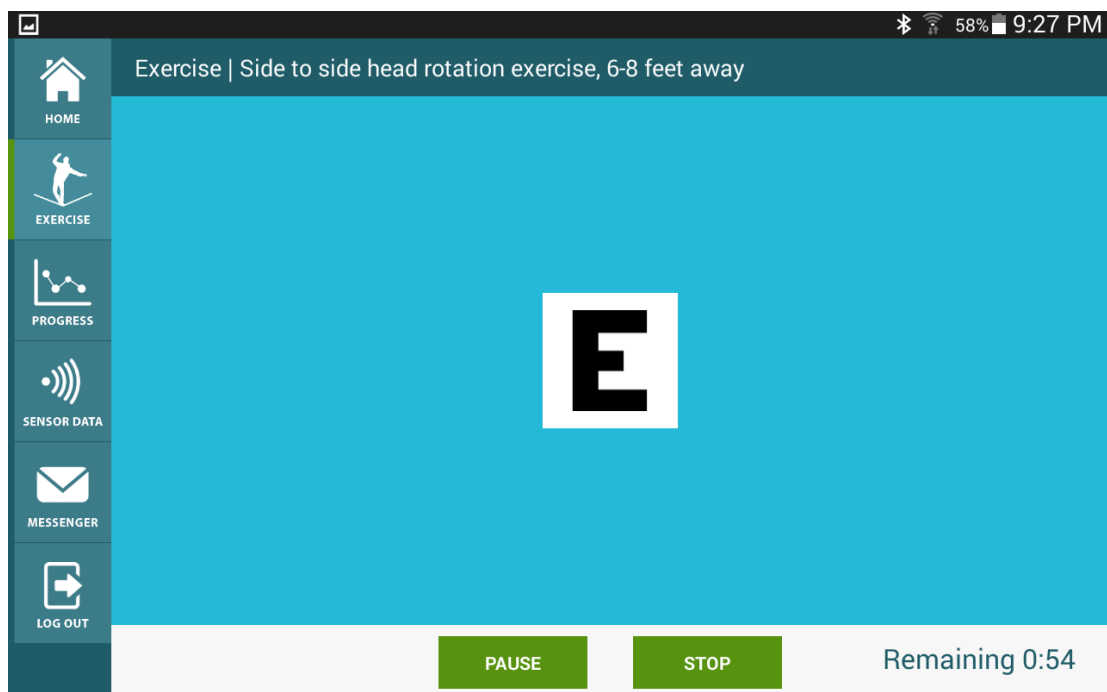


FIGURE 2.6 EXERCISE

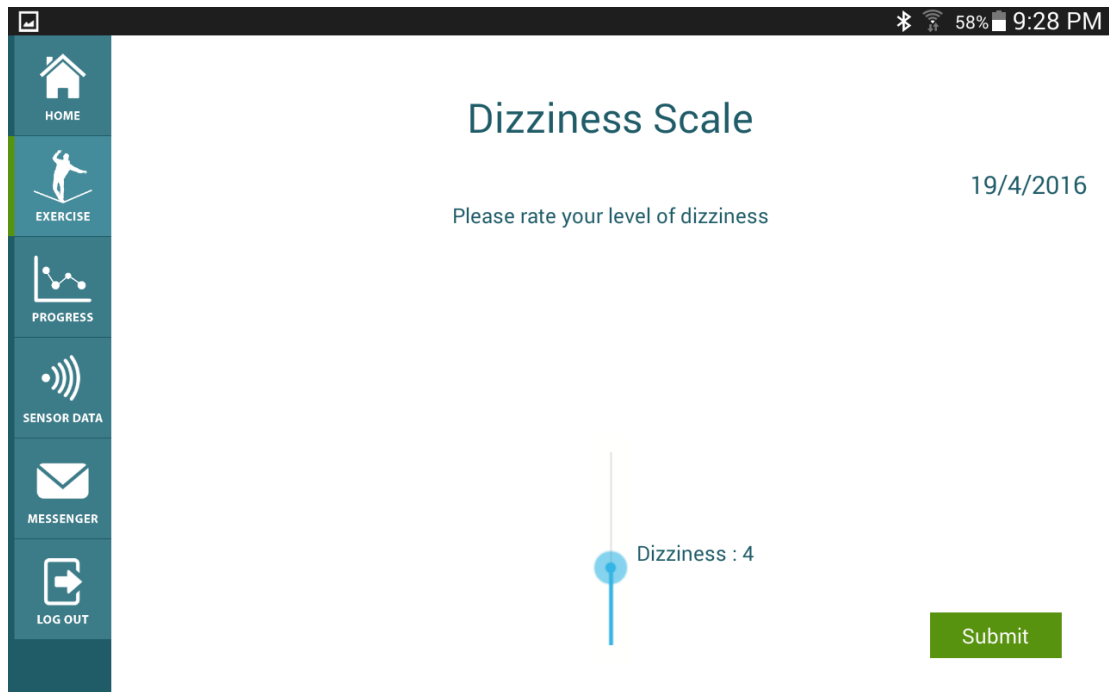


FIGURE 2.7 DIZZINESS SCALE

There were various progressions of the exercises involving optokinetic stimulation (Figure 2.8 and 2.9. These were available in Week 6 on the diary of exercises. Unfortunately the messenger function (as seen on the left in the home screen-Figure 2.2) was not available in this version of VRA, nor was the sensor data. Therefore this version was purely for adaptation exercises only.

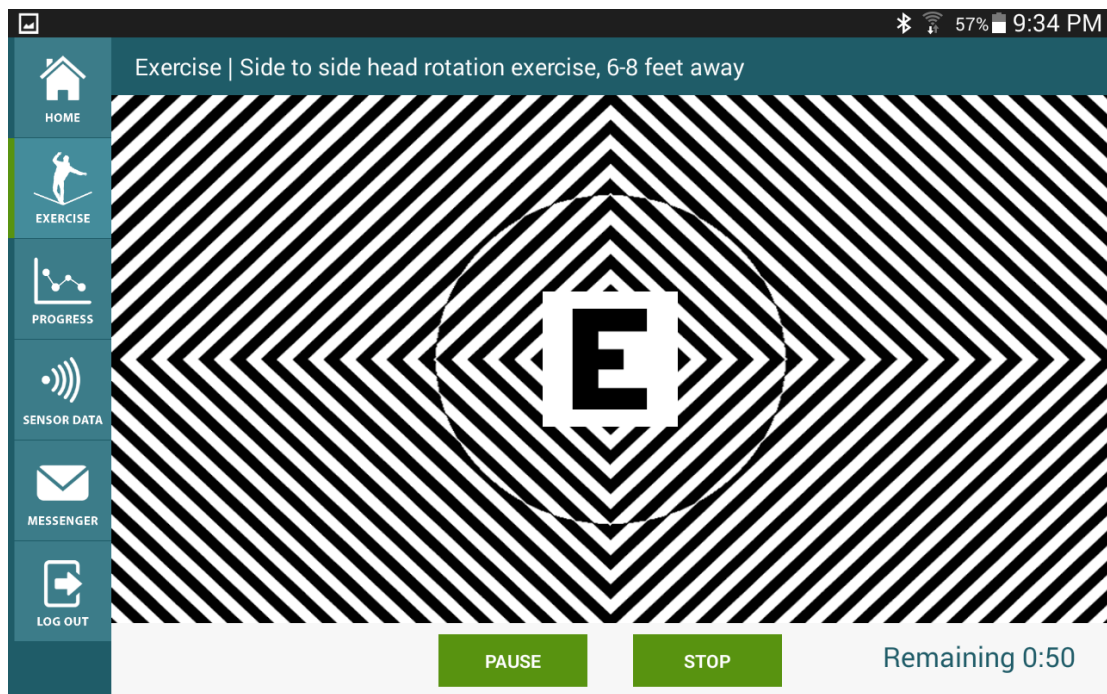


FIGURE 2.8 OPTOKINETIC STIMULATION EXAMPLE 1

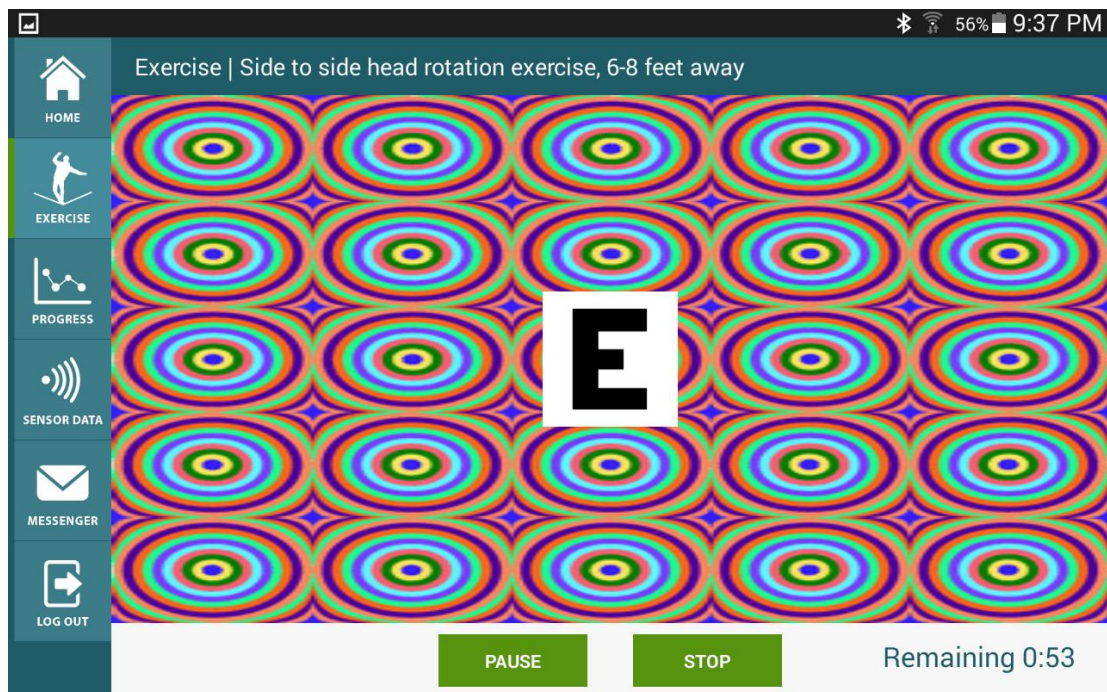


FIGURE 2.9 OPTOKINETIC STIMULATION EXAMPLE 2

## **2.6 Procedure**

The participant was initially assessed by the PI for suitability of participation through the use of the clinical Dynamic Visual Acuity Test (DVAT). The DVAT is a standard test used to assess all vestibular patients in Midlands Regional Hospital Tullamore. The clinical use of the DVAT involves reading an Early Treatment Diabetic Retinopathy Study (ETDRS) eye chart (Appendix 2.11) with the head still. The patient then read the chart with the PI oscillating the head at two Hertz. The test was standardised by using a metronome as recommended by Dannenbaum et al (2005) and Dannenbaum et al (2009). In healthy individuals, visual acuity changes by one line in younger individuals and two lines in older individuals. In patients with uncompensated vestibular loss, visual acuity decreases by three to four lines (Herdman and Clendaniel, 2014). This clinical measure has been proven to be sufficiently reliable by Herdman et al (1998). Therefore, patients with a decrease of three or more lines in the DVAT began gaze stability exercises. The gatekeeper then approached the patient to inform them of the study and provide the information letter, invitation leaflet and consent form (Appendices 2.2, 2.3, 2.4).

The participant was reviewed three times before the study began to ensure comfort with the paper based gaze stability exercises. On their third session the participant signed their consent form and was given the opportunity to ask the PI any questions. The participant also signed the equipment loan agreement form to ensure return of the tablet to the PI after the study (See Appendix 2.12). Baseline characteristics of age, gender, level of education as per the National Framework of Qualifications (Appendix 2.13), original DVAT score and diagnosis were then recorded. The participant then completed the Dizziness Handicap Inventory (DHI-

Appendix 2.14) which is a validated 25-item questionnaire used for the evaluation of problems as a result of dizziness (Jacobson and Newman, 1990; Enloe and Shields, 1997). The participant also completed a Visual Analogue Scale (VAS) for dizziness experienced at that moment in time (Appendix 2.15). This is a valid tool for measuring a characteristic or attitude that varies across a range of values and cannot be easily objectively measured (Wewers and Lowe, 1990).

Once all baseline measurements were recorded the participant then undertook semi structured training in the use of the tablet and VRA application with the PI. The training was scripted (Appendix 2.16) but allowed questions to be asked at any stage during it. The training was timed using a stopwatch from the first sentence on the script and was stopped once all questions were answered at the end. This time was recorded for each participant as a measure of their efficiency in using the app. The participant was then given this training script with their login details on it.

The participant then took the tablet home for one week, or if an in-patient kept the tablet for one week, and used it instead of the paper based gaze stability exercises. Depending on the number of weeks they had participated in vestibular rehabilitation, they then progressed to this week on the VRA. Therefore if Participant One was in his/her fourth week of vestibular rehabilitation, they then started on Week Four exercises on the VRA. After the week, the tablet was returned and the patient completed the SUS (Appendix 1.1) and SUMI (Appendix 1.2) forms and then participated in a semi structured interview with the PI (Appendix 2.17). Usual treatment began again from that point onwards.

The study took place in the physiotherapy out-patient department in Midlands Regional Hospital Tullamore or at the participant's bedside if an in-patient. All exercises were performed in the seated position.

Standardisation was ensured by following scripts provided for the training and interview.

Two tablets used during the study were provided by the academic supervisor and the other was provided by the PI. The tablets used were two Samsung Galaxy Tab versions (a ten inch screen and a seven inch screen) and one Samsung Galaxy note 10.1, each tablet with Android version 4.2 or later.

## **2.7 Research Instruments**

The SUS is a ten item questionnaire using Likert scales that quantifies a user's attitudes to a technological system. Each question transferred to a score of 0-40. This number was then multiplied by 2.5 to give a score of 0-100. Bangor et al (2008) found that scores above 68 were above average while scores less than 68 were below average. This scale has been validated by Bangor et al (2008).

The SUMI scale is based in University College Cork (UCC), Ireland and is a 50 question scale that measures overall satisfaction. This scale was analysed in UCC and resulted in a global score along with five additional subscales of efficiency, affect, helpfulness, controllability and learnability. This scale was included in the study as it complemented the ISO's (1998) definition of usability well.

The final research instrument was the interview. This consisted of eight questions with prompts aimed at assessing the three different areas of usability (efficiency, effectiveness and satisfaction), general use of technology and exercise adherence. This interview was developed through a post-positivist paradigm in which there



was a clear statement of hypothesis from the PI (a negative correlation between age and usability). A phenomenological methodology was used in the interview whereby the participants described their lived experience of the VRA (Flick, 2009). The PI ensured the questions and prompts were balanced throughout.

## **2.8 Statistics**

All data was entered onto a Microsoft Excel Spreadsheet initially before being exported to SPSS statistics package (International Business Machines SPSS Statistics Version 22) for analysis. Firstly descriptive statistics were used to gain a better understanding of the participants and assess normality of data. This was followed by assessments of correlations which investigated the association between the SUS and each baseline characteristic.

The SUMI data was analysed by a programme called SUMISCO. SUMISCO carried out all the scoring activities and allowed export of files which became evaluation reports to word processors and scored data files to spreadsheets. The raw SUMI question data was coded, combined and transformed into a global subscale and five additional subscales of efficiency, affect, helpfulness, controllability and learnability. This data was entered online and sent to University College Cork for analysis with the SUMISCO programme. Once results were received by the PI, they too were assessed for correlation with each baseline characteristic.

The interview was typed and then thematic analysis was used. This involved the PI coding the data with various themes that appeared in it. The PI ensured there was consistency of coding by analysing an extract of an interview, then re-analysing the same unmarked piece three weeks later and comparing the two

pieces (intra rater reliability). Internal consistency should be 80 per cent or above according to Miles and Huberman (1994). Inter rater reliability was also assessed by asking a colleague to code an extract of an interview that was previously coded by the PI. If the correlation between the two pieces was 70 per cent, this was deemed acceptable (Miles and Huberman, 1994). Triangulation of data also occurred with a comparison drawn between the quantitative and qualitative results.

## **CHAPTER 3 RESULTS**

### **Introduction**

The aim of the study was to assess the usability of the VRA on an electronic tablet in patients with a complaint of dizziness.

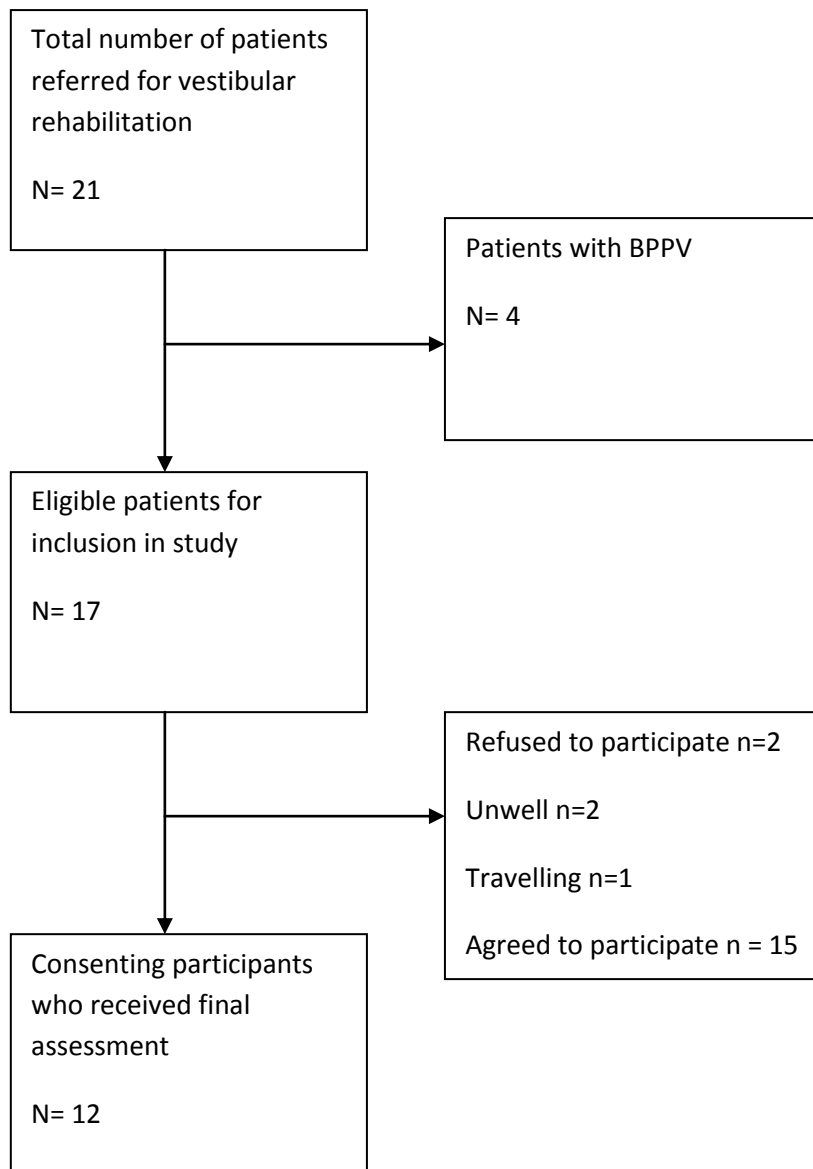
The objectives of the study were to assess usability under three main headings of effectiveness, efficiency and satisfaction as recommended by the International Standardisation Organisation (ISO) in 1998.

The methodology described in Chapter 2 was followed through and the following chapter will outline the study's results.

### **3.1 Participant Flow**

Recruitment took place from October 2015 to March 2016. Twenty-one patients were referred for vestibular rehabilitation and screened for inclusion. Seventeen were eligible for inclusion with 15 agreeing to participation. The final number of consenting participants was 12. The flow of patients is outlined in Figure 3.1

FIGURE 3.1 PARTICIPANT FLOW



### 3.2 Baseline Demographic and Distribution of Data

The mean age of participants was 60 years (mean = 59.92, SD = 22.14). There were eight female participants (66.67%) and 4 male participants (33.33%) in the study. The levels of education included level 5 (n=2), level 6 (n=3), level 7 (n=2) and level 8 (n=5) as per the NFQ levels of education (Appendix 2.13). As the sample size was less than 50 (n=12) the Shapiro-Wilk statistic was used to assess

baseline and post intervention data distribution. Significant values where  $p > 0.05$  indicated normal distribution of data. The results are summarised below in Table 3.1.

Characteristic	Mean	Standard Deviation	P value
<b>Age</b>	59.92 years	22.14	0.456
<b>NFQ</b>	7.00*	2**	0.023***
<b>DVAT</b>	3.50*	1**	0.005***
<b>VAS</b>	1.83	1.74	0.133
<b>DHI</b>	34.50	22.17	0.069
<b>Training Time</b>	00:09:24	03:49:07	0.092
<b>SUS</b>	68.96%	30.98	0.111
<b>SUMI Global Score</b>	51.42	18.05	0.127
<b>SUMI Efficiency</b>	47.00	21.69	0.062
<b>SUMI Affect</b>	52.42	17.90	0.194
<b>SUMI Helpfulness</b>	57.50*	25**	0.011***
<b>SUMI Controllability</b>	47.58	15.40	0.570
<b>SUMI Learnability</b>	47.58	20.73	0.076

\*indicates median value \*\*indicates interquartile range \*\*\*indicates skewed data

TABLE 3.1 BASELINE CHARACTERISTICS

The majority of data were normally distributed except for NFQ, DVAT and SUMI helpfulness. Therefore non-parametric tests were employed for these three variables while parametric tests were used for all other variables.

The participants were divided into two groups; those who had never used an app (n=5) and those who had (n=7). Previous use of technology was measured in the semi structured interview where participants were asked if they had ever used a smartphone, a tablet or an app previously. Fifty-eight percent of participants (n=7) had previously used an app. Appendix 3.1 shows more detail on previous technology usage.

### **3.3 Post Intervention Quantitative Outcome Variables**

The two quantitative measures used in this study were the SUS and SUMI. Correlations between these two variables and age, VAS, DHI and training time were established using Pearson Product Moment correlation (r).

#### **3.3.1 Age**

Pearson Product Moment correlation (r) was used to determine a relationship between age and SUS. A moderate negative correlation was shown ( $r = -0.7$ ,  $p$  value = 0.01).

Pearson Product Moment Correlation (r) found a moderate negative correlation between age and global SUMI score where  $r = -0.68$  ( $p$  value = 0.2). The subscales of efficiency, affect and controllability in SUMI showed a moderate negative correlation on Pearson Product Moment Correlation where  $r = -0.63$  ( $p = 0.03$ ),  $r = -0.6$  ( $p = 0.04$ ),  $r = -0.64$  ( $p = 0.03$ ) respectively while learnability showed a strong negative correlation on Pearson's test ( $r = -0.8$ ,  $p = 0.002$ ). The relationship between helpfulness and age was determined by Spearman's Rank Correlation. There was a moderate negative correlation again between helpfulness and age where  $\rho = -0.52$  ( $p = 0.08$ ).

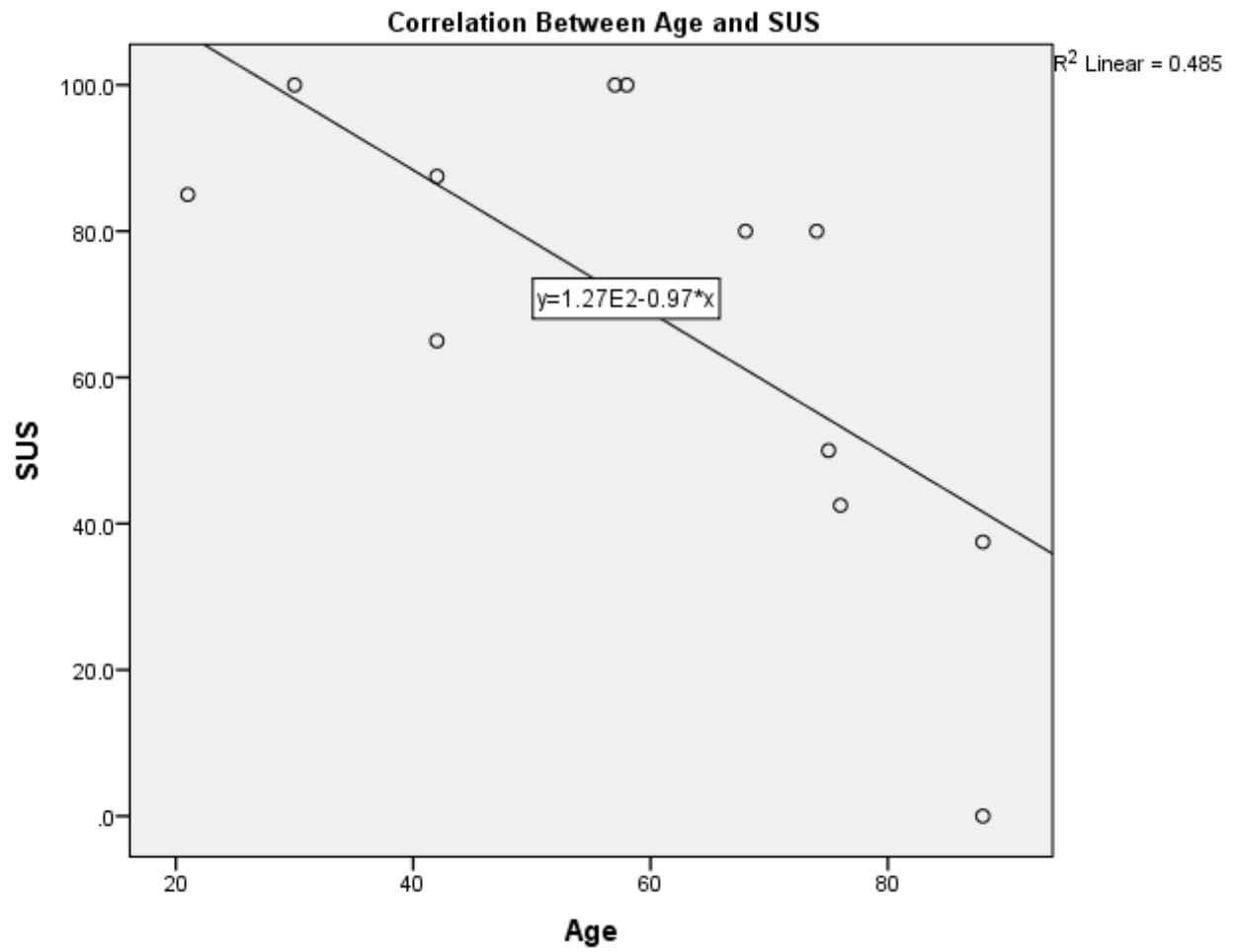


FIGURE 3.2 CORRELATION BETWEEN AGE AND SUS

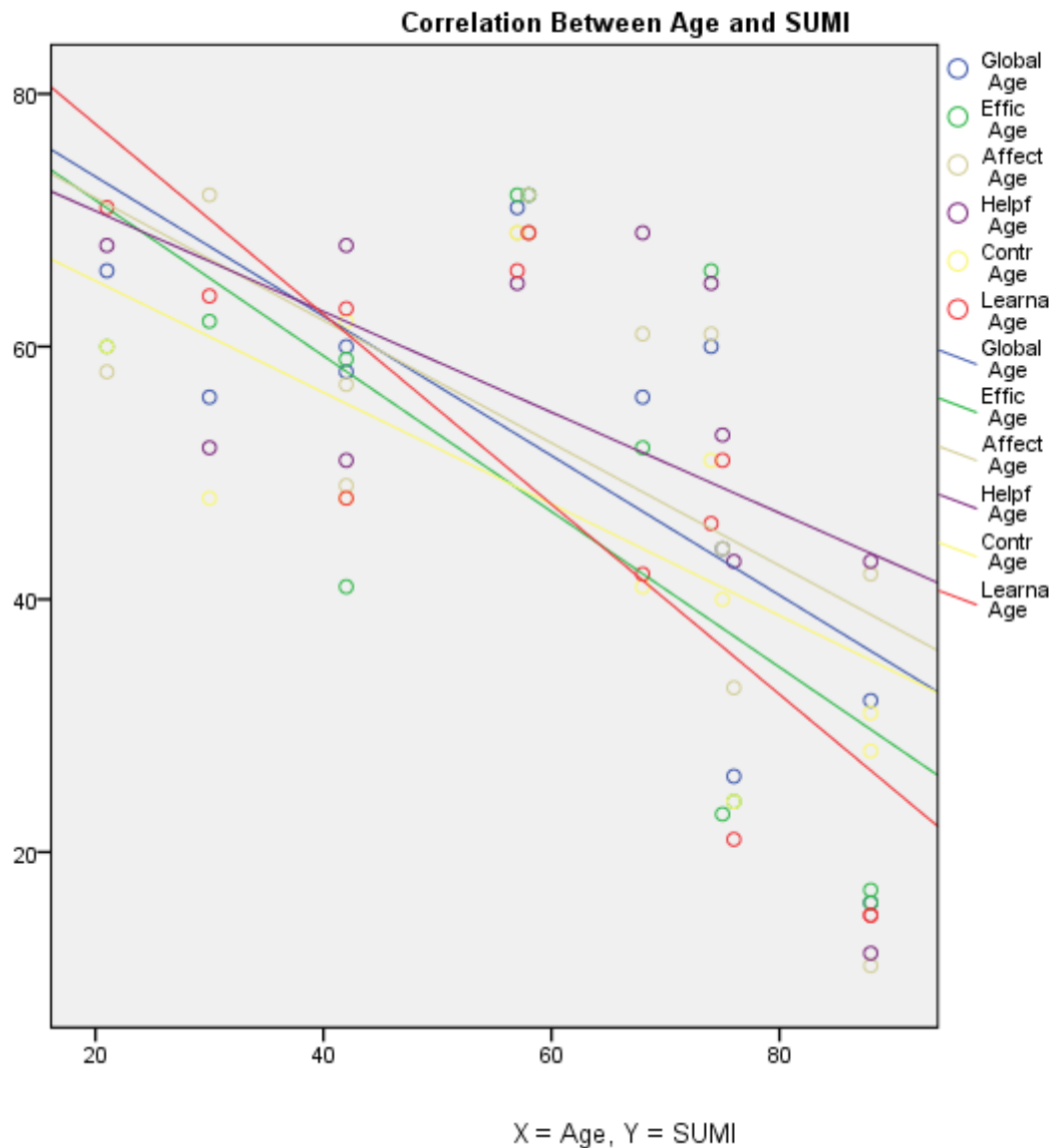


FIGURE 3.3 CORRELATION BETWEEN AGE AND SUMI

In order to quantify the effect on usability a linear regression analysis was conducted. The unstandardised Beta co-efficient value was  $B = -0.97$  ( $p = 0.01$ , CI 95%) for age and 127.32 for SUS where age was the dependent variable and the SUS was the independent variable.

### 3.3.2 Previous Use of Apps

Previous use of apps was divided into two groups; Group 0 which had never used an app and Group 1 which had previously used an app. A two-sample t test was



conducted to determine whether there was a difference between the two groups' SUS score. The result was significant with a p value of 0.03. The mean score of Group 0 was 43.13 while the mean score of Group 1 was 81.88 therefore resulting in a mean difference of -38.75.

A two-sample t test was used to determine whether there was a difference between the mean SUMI global, efficiency, affect, helpfulness, controllability and learnability scores and previous use of apps. Again the results were significant for the SUMI global score (p value = 0.02) with a mean difference of -23.88. There was a significant result for the SUMI efficiency score (p value = 0.03) with a mean difference of -27.38. The SUMI affect score was statistically significant (p value = 0.03) with a mean difference of -22.75 between Group 0 and Group 1 while the SUMI controllability score was also statistically significant (p value = 0.01) with a mean difference of -21.5 between the groups. The SUMI subscales of helpfulness and learnability showed statistically insignificant results (p values of 0.13 and 0.07 respectively) with mean differences of -15.88 and -23 respectively between the two groups respectively.

Outcome Measure	No Previous Use of Apps Mean (SD)	Previous Use of Apps Mean (SD)	Mean Difference	p value
<b>SUS</b>	43.125 (33)	81.875 (21.66)	-38.75	0.03
<b>SUMI Global</b>	35.5 (17.92)	59.375 (12.55)	-23.875	0.02
<b>SUMI Efficiency</b>	28.75 (15.9)	56.125 (18.59)	-27.375	0.02
<b>SUMI Affect</b>	37.25 (20.95)	60 (10.88)	-22.75	0.04
<b>SUMI Helpfulness</b>	44.25 (24.02)	60.125 (9.95)	-15.875	0.13
<b>SUMI Controllability</b>	33.25 (8.54)	54.75 (12.85)	-21.5	0.01
<b>SUMI Learnability</b>	32.25 (17.04)	55.25 (18.7)	-23	0.07

TABLE 3.2 PREVIOUS USE OF APPS T TEST RESULTS

### 3.3.3 DHI

There was no linear relationship between DHI and SUS ( $r=-0.02$ ,  $p = 0.95$ ) using Pearson Product Moment Correlation. Similarly there was no linear relationship found between the SUMI subscales of global ( $r=-0.11$ ,  $p = 0.73$ ), efficiency ( $r=0.1$ ,  $p = 0.76$ ), affect ( $r=-0.06$ ,  $p = 0.85$ ), controllability ( $r= -0.03$ ,  $p = 0.94$ ) and learnability ( $r= -0.01$ ,  $p = 0.98$ ) and DHI. There was a weak negative correlation between helpfulness and DHI using Spearman's Rank Correlation where  $\rho=-0.34$  ( $p = 0.28$ ).

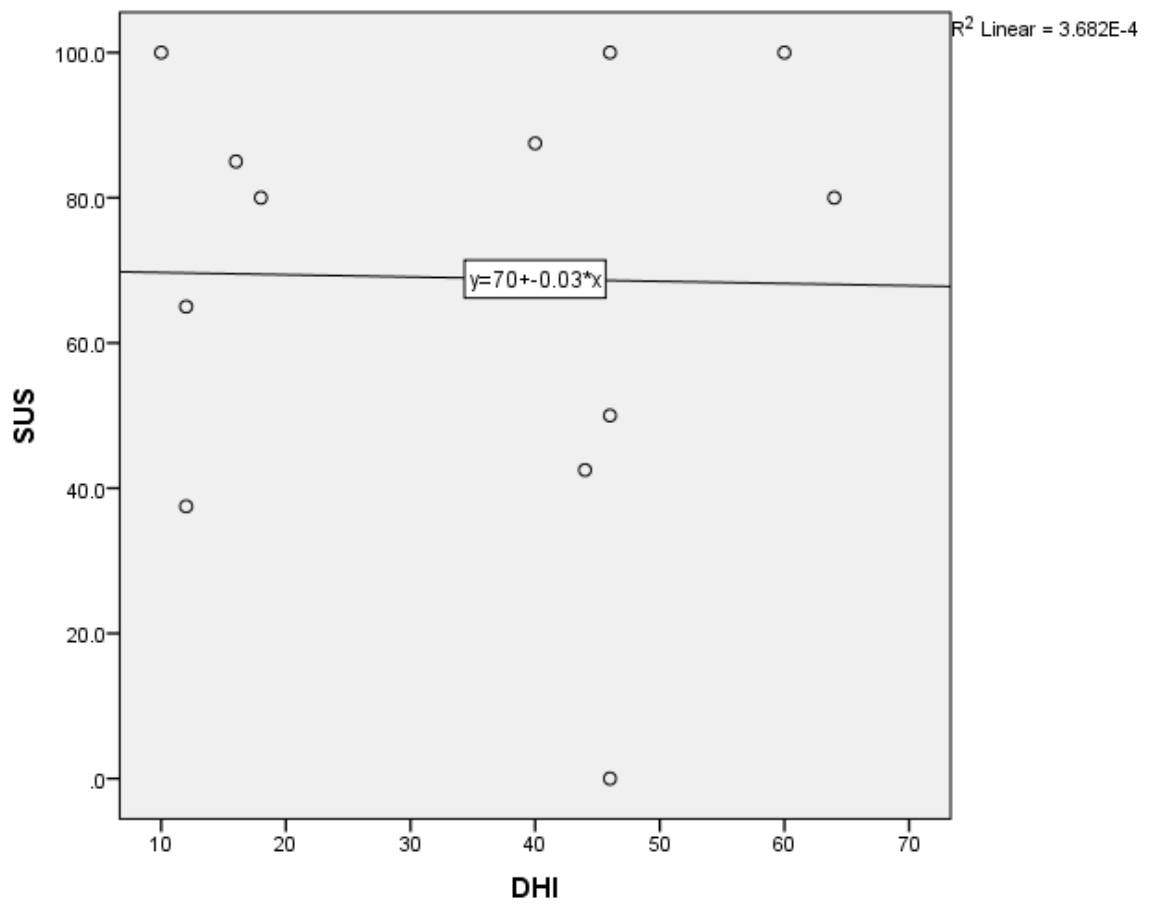


FIGURE 3.4 CORRELATION BETWEEN DHI AND SUS

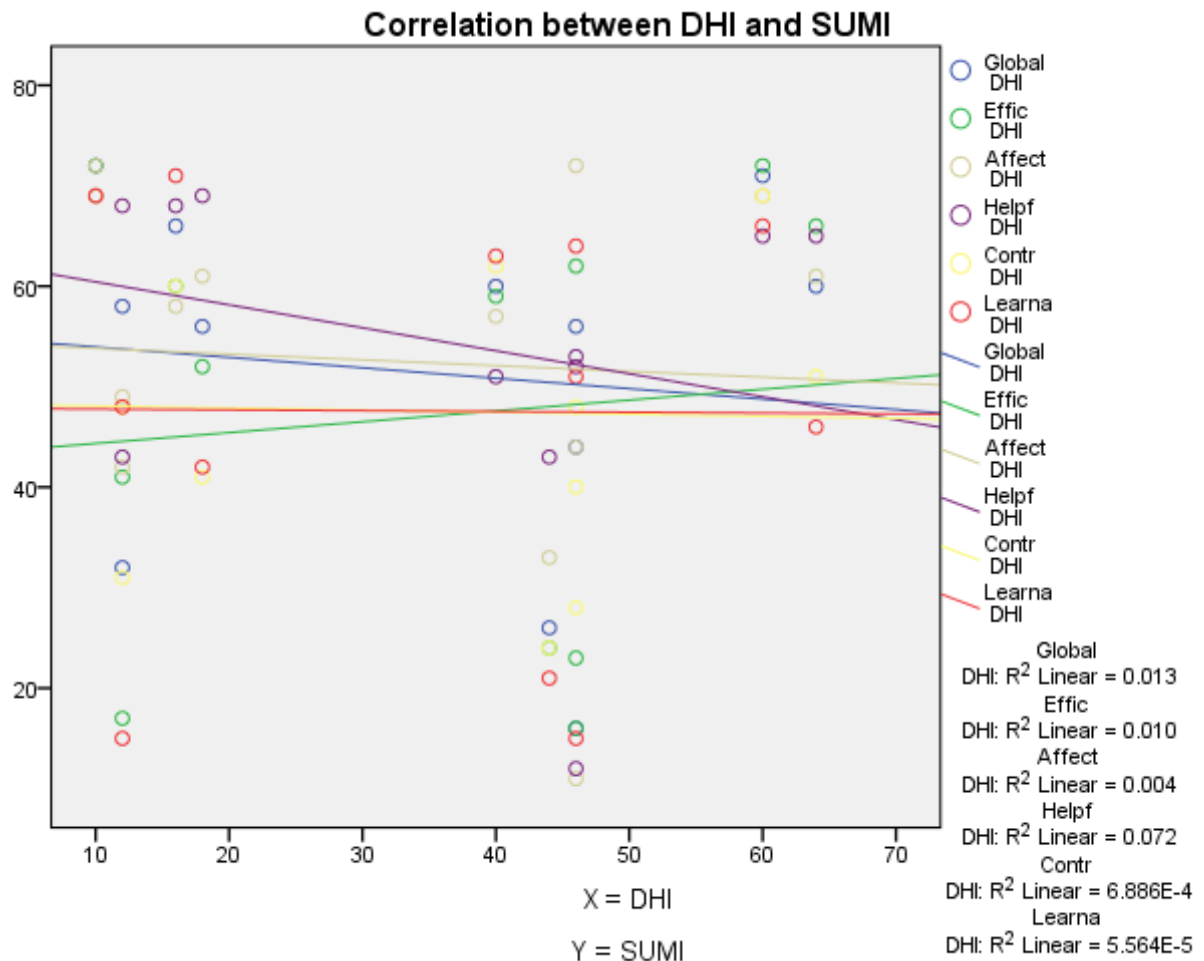


FIGURE 3.5 CORRELATION BETWEEN DHI AND SUMI

### 3.3.4 VAS

There was a weak positive correlation between SUS and VAS ( $r=0.27$ ,  $p = 0.4$ ) using Pearson Product Moment Correlation. There was a weak positive correlation found between VAS and the SUMI subscales of global ( $r= 0.44$ ,  $p = 0.16$ ), efficiency ( $r= 0.4$ ,  $p = 0.2$ ), affect ( $r=0.29$ ,  $p = 0.37$ ), controllability ( $r=0.41$ ,  $p = 0.19$ ) and learnability ( $0.34$ ,  $p = 0.28$ ) using Pearson Product Moment Correlation. Spearman's Rank Correlation also found a weak positive correlation between helpfulness and VAS ( $\rho=0.47$ ,  $p = 0.13$ ).

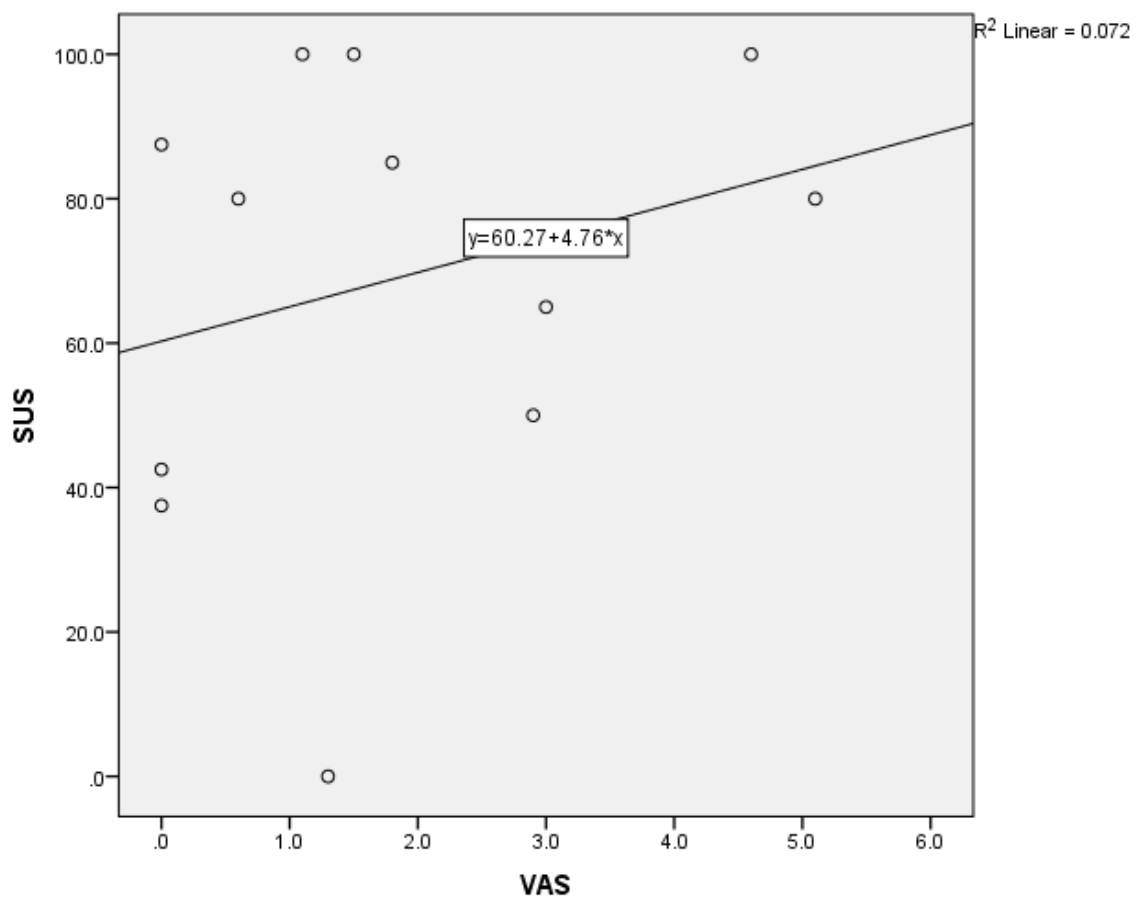


FIGURE 3.6 CORRELATION BETWEEN VAS AND SUS

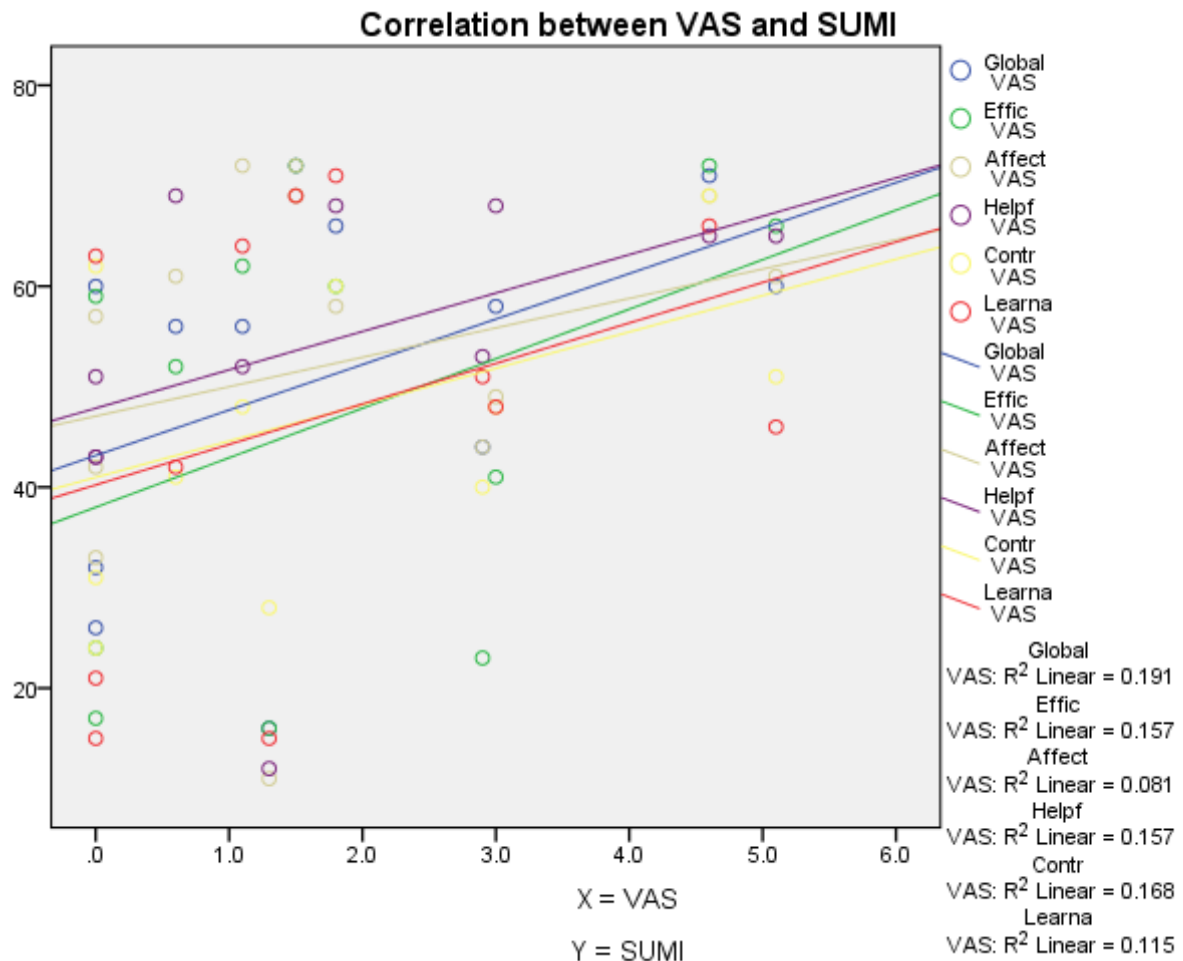


FIGURE 3.7 CORRELATION BETWEEN VAS AND SUMI

### 3.3.5 Training Time

There was a strong negative correlation between training time and SUS ( $r=-0.84$ ,  $p = 0.00$ ) using Pearson Product Moment Correlation. A linear regression analysis was completed to quantify the difference between SUS and training time. The unstandardised Beta coefficient  $B= -0.11$  (CI 95% lower bound;  $-0.17$ , upper bound;  $-0.06$ ) and  $p=0.001$ . There was also a strong negative correlation between global SUMI score ( $r=-0.8$ ,  $p = 0.002$ ), affect ( $r=-0.75$ ,  $p = 0.005$ ), and learnability ( $r= -0.92$ ,  $p = 0.00$ ) and training time. A moderate negative correlation was shown between efficiency ( $r= -0.73$ ,  $p = 0.007$ ) and controllability ( $r= -0.74$ ,

$p = 0.006$ ) and training time. Spearman's Rank Order Correlation showed a weak negative correlation between helpfulness and learnability where  $\rho = -0.43$  ( $p = 0.16$ ).

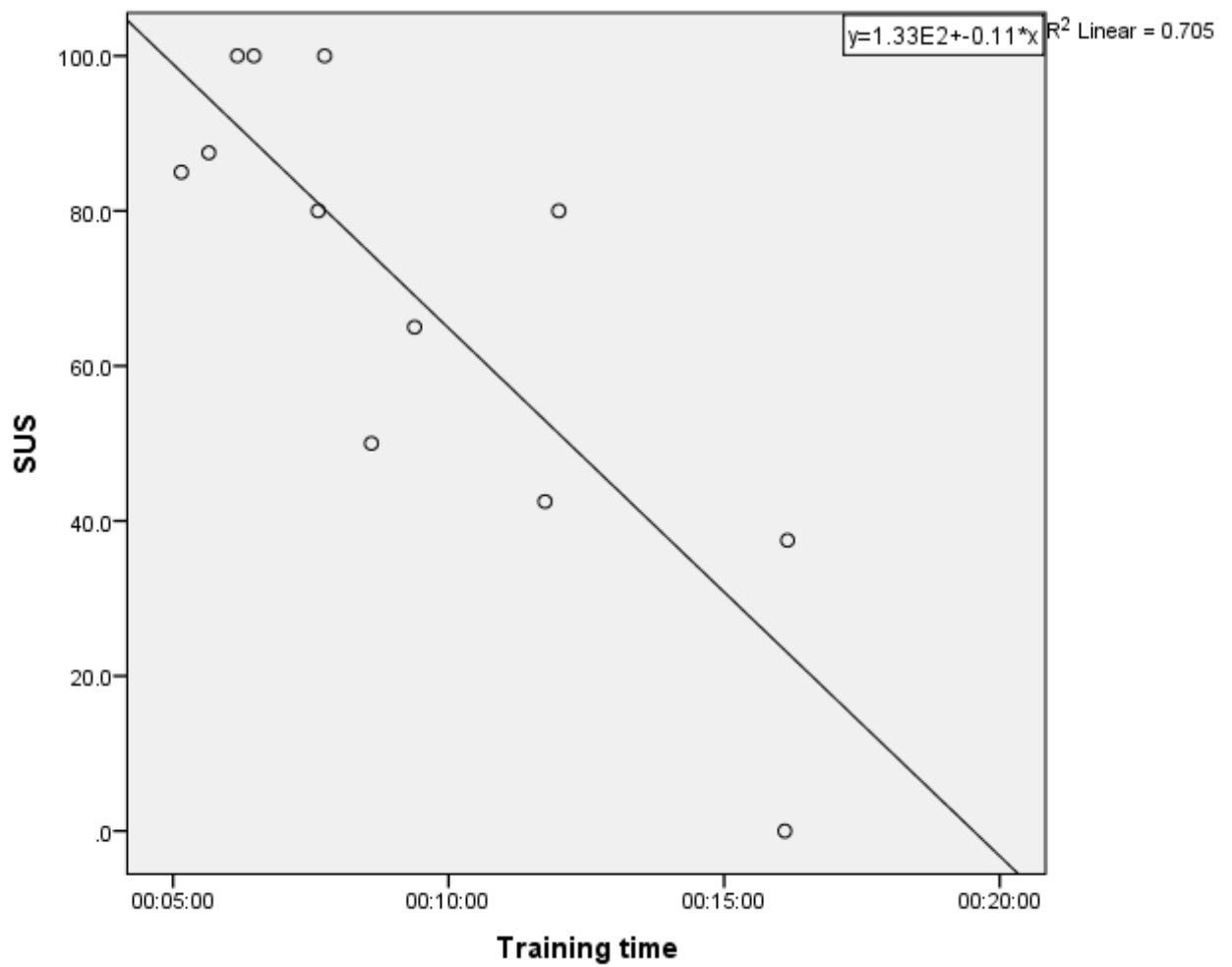


FIGURE 3.8 CORRELATION BETWEEN TRAINING TIME AND SUS

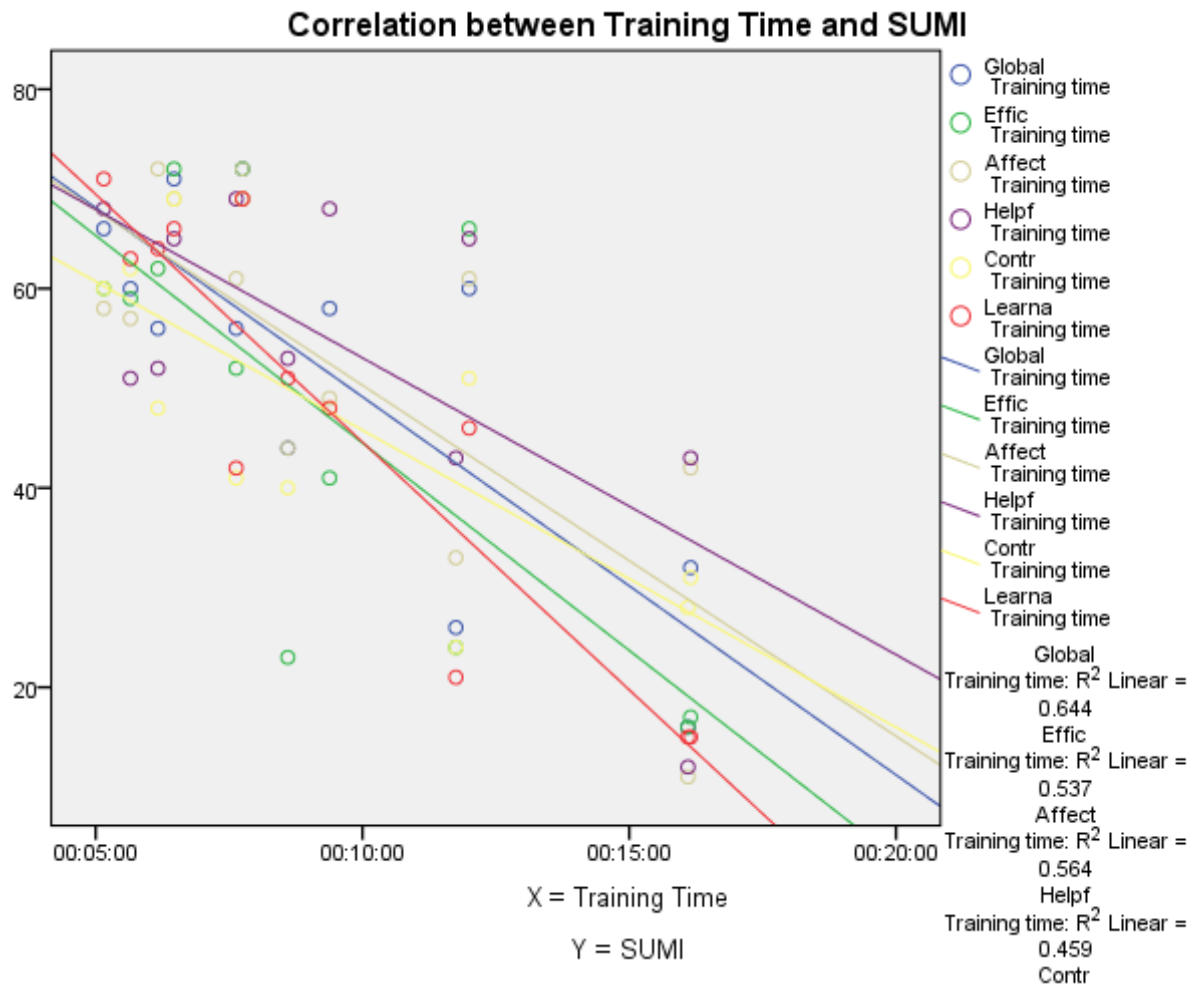


FIGURE 3.9 CORRELATION BETWEEN TRAINING TIME AND SUMI

### 3.4 Post Intervention Qualitative Outcome Variables

The semi structured interviews were the research instrument used for the qualitative component of this research. The following table illustrates the main themes and sub themes for the study.



TABLE 3.3 MAIN THEMES AND SUBTHEMES

Themes Questioned	Themes Emerging
<b>Effectiveness</b>	A) Complexity of Technology B) Age “Teaching the Old Dog New Tricks”
<b>Efficiency</b>	C) Unfamiliarity D) Fear
<b>Convenience</b>	E) Accessibility F) Discretion G) Routine
<b>Satisfaction</b>	H) Preference I) Recommendations

### 3.4.1 Theme Questioned: Effectiveness

Effectiveness is one of the key aspects of usability as defined by the ISO (1998) and is classified as “the accuracy and completeness with which specified users can achieve specified goals in particular environments” (ISO, 1998).

One of the main themes that emerged from participants recounting their effectiveness with the app was the complexity of technology. Four of the participants felt that the VRA was too complicated for everyday use;

*“It’s just setting it up to do it you’d be better off if you had the paper, cos I was at home, the E was on the fridge” (10)*

*“And that {the paper} worked like that and that was steady, but that yoke {VRA}, I couldn’t make tail nor trace of it” (1)*

While another four participants commented on the simplicity of the VRA;

*“I like the simplicity of it, you just touch the screen a couple of times and there you go, it’s done”(9)*

These varying levels of complexity therefore affected the participants' adherence to VRA. The majority of the participants were more adherent with their original adaptation exercises (n=9);

*"On the paper I was very good, but that fella {the tablet}, once or twice.*

*Whenever I thought of it" (2)*

However three of the participants reported increased compliance with the VRA and that this contributed to improved technique and progress. When asked about their compliance;

*"About three times more! I was lucky if I did the paper ones twice a day whereas that was...and like you might not even do 2 exercises with the paper one, you'd do one and I'd say I'd do the other one after whereas I did that at least three times more" (9)*

*"Yeah whereas the other ones I could miss. You know on the paper I'd do 3 or 4 a day, but on that it was at least 5 or more the way it was laid out. You'd have more progress on that one" (7)*

Three of the participants felt that using technology for rehabilitation reminded them to complete their exercises more regularly;

*"Yeah cos when the tablet was there I said "ok I need to take this out now and do my exercises on it""(4)*

Another theme that emerged as participants described their effectiveness with the app was age and the idea that you “can’t teach old dog new tricks”. Three of the participants felt that age was a barrier to using the VRA effectively;

*“To be honest I don’t know is it worth it at this stage, the hassle in my brain...at 76 it’s hard to take in things than say when I was 56 or 66 even” (8)*

Even the younger participants admitted that VRA may pose problems with elderly patients;

*“Older people might not...like they’d probably prefer a piece of paper” (12)*

### **3.4.2 Theme Questioned: Efficiency**

Efficiency is defined as “the resources expended in relation to the accuracy and completeness of goals achieved” (ISO, 1998).

One of the main themes emerging from efficiency with VRA was unfamiliarity. Seven of the participants felt there was a learning curve with VRA;

*“Ah yeah I was much better towards the end of the week” (7)*

But for some, the unfamiliarity with technology was still a huge barrier, despite any learning curve;

*“I found it hard, because the unknown, you know what I mean? The unknown and I trying to pick, and then I’d forget and have to ask again” (8)*

This unfamiliarity with technology directly affected the participants' level of comfort with VRA. The majority of participants were comfortable with VRA and did not experience any more difference than the original paper exercises;

*"No difference really at all" (4)*

However four of the participants noticed increased dizziness and felt uncomfortable during the exercises;

*"Like I was 5 or 6 throughout the week {on VAS dizziness scale} using the slide scale. I don't know if it was the colours" (10)*

Another theme emerging from participants' efficiency with VRA was fear. This fear again relates to unfamiliarity with technology as participants were afraid to do damage to the tablet;

*"Now maybe it was because I didn't know how to use it and anything that you can't do properly you're afraid to do any harm, even though my grandson would say "Nanny you can't do any harm to that, don't be afraid" you know? (8)*

### **3.4.3 Theme Questioned: Convenience**

The participants reflected how convenient the app was with accessibility one of the main themes emerging. Five of the six under 65s felt that it would be more beneficial to have on the phone as it would improve accessibility;

*"Like if you're in work and you have to do the exercises you could just take out the phone and do them" (10)*

Also by having the app on a smartphone it would improve patient discretion,  
another theme highlighted by the participants;

*“You see the paper one; you can have it with you. I had the paper in the cover of my phone so even sitting on the loo you could do it. It’s just, you’re not going to go into the loo and open up a tablet whereas with your phone or a piece of paper, ideal. Like you could do it anywhere in any situation” (11)*

For some participants, the new routine increased the convenience of VRA;

*“because I lose the paper like. So I had to write out an E every time. Whereas it’s on the screen”*

However for other participants, the change to their original exercise routine proved too much;

*“Just that when you’re sitting there looking at the clock {paper exercises} you can do it you know” (3)*

*“It’s just setting it up to do it you’d be better off if you had the paper, cos I was at home, the E was on the fridge” (10)*

#### **3.4.4 Theme Questioned: Satisfaction**

Satisfaction is defined as the comfort and acceptability of the work system (ISO, 1998). Seven of the participants preferred the original paper exercises to the VRA, some more strongly than others;

*“Oh I wouldn’t give that to anybody, I’d tell them to throw it in the canal” (1)*

*“Oh the paper ones, yeah. Because it’s so clear and so easy! Sure it’s there! All you have to do is look down along” (2)*

*“I preferred the tablet because it made me do it number one, because you wouldn’t forget it as much ‘twas much easier and I left the tablet in a particular place where it would remind me everytime. It made the repetition of the exercises, the number of times much much easier” (9)*

*“Ya. I think it has improved my dizziness now. I think so now in the last few days it has” (3)*

There were several recommendations suggested by the participants which are outlined in Table 3.4. The most prevalent recommendations were technical issues with the app itself and that it should be available to download on smartphones.

TABLE 3.4 PARTICIPANT RECOMMENDATIONS

Number of Participants	Recommendation
2	Improve touch screen calibration
2	Improve home screen and diary so it reflects participant
1	Need bigger letter / bigger screen
1	Needs more exercises, not just adaptation
1	Needs alarm / ability for reminder to be set
3	Would be better if available on smartphone
1	App shut down unexpectedly
1	Exercises did not stay on recommended week

### Summary of Findings

Overall it would appear that age, previous use of apps and training time had the largest impact on usability of the VRA. Similarly the dominant themes were complexity of technology, age, unfamiliarity, fear, accessibility, discretion, routine, preference and recommendations. Each of these results will be discussed in more detail in Chapter 4.

## **CHAPTER 4: DISCUSSION**

### **4.1 Introduction**

This study assessed the usability of the Vestibular Rehabilitation Application (VRA) in a group of patients undergoing vestibular rehabilitation. There were significant results for age, previous use of apps and training time when correlated with usability. Other baseline characteristics did not demonstrate strong correlations.

The subthemes explored in the post intervention interview were complexity of technology, age, unfamiliarity, fear, accessibility, discretion, routine, preference and recommendations. The discussion that follows will concentrate on these themes found in the interviews and triangulation of data will occur between both sets of qualitative and quantitative results all in the context of previous research.

### **4.2 Statistical Power**

At least 12 participants were calculated as necessary to obtain sufficient data on the SUS (Lewis and Sauro, 2009) and the SUMI (Kirakowski, 1993). Twelve participants were recruited however results must be interpreted with caution where the sample size was divided into two groups (previous use of apps versus no previous use of apps). With less than 12 participants in each of these groups there is a higher risk of Type II errors regardless of confidence intervals.

### **4.3 Age and Usability**

The null hypothesis was rejected for age and usability as there were strong negative correlations shown between age and usability on both the SUS and SUMI scales. This shows that the older the participant, the less usability they



showed on the VRA. For every one year decrease in age, an increase in 1.27% was noted in usability, as measured on the SUS. As the youngest participant was 21 years of age, by the time an adult reaches 65, they can expect their usability to have decreased by almost 56%. This is an effective “quick screen” tool that could be used in clinical practice whereby a patient’s predicted loss of usability could be calculated based on their age, therefore giving the clinician a better idea of how appropriate the app is for this particular patient’s treatment.

Similarly there was a strong negative correlation between learnability and age showing that the older the participant, the slower they become at efficiently using the VRA. This coincided with a study by Zajicek (2001) who reported that age related memory changes and their effects on learning are the main reason for the difficulties older people have in using computers. Zajicek (2001) reported that the research in the area of Age Associated Memory Impairment (AAMI) showed that age affected the fluid memory mostly and that it left fixed memory (knowledge and skills) relatively untouched. This fluid memory is the type of memory that is needed for learning the use of computers. Similarly Zhao (2000) noted that the decline in elderly people in their physical, sensory and cognitive functions happens at different rates in each individual. As a result of varying levels of function in the elderly, it is therefore difficult to define “the elderly” as one consistent group. This therefore presents a challenge in the design of technology for this population.

Ageing had a strong presence in the qualitative results also. Four of the six over 65s were not effective in their use of the VRA due to their age. These four participants felt the VRA was too complicated and that it was too much effort out of their normal exercise routine. Eight of the participants were more adherent to

the original paper based exercises and of these eight participants, five were over 65. There was also an element that age was a barrier to effective use of the VRA. Blit-Cohen and Litwin (2004) also found that elderly people with no previous use of technology felt that their age and health status was a barrier. This was reflected in this study where one of the participants in particular blamed her history of CVA while two other participants blamed age related macular degeneration for their ineffective use of the app.

#### **4.4 Previous Use of Apps**

Seven of the 12 participants had previous use of apps as measured in the interview. A two sample t test showed a mean difference of -38.75 between those who had no previous use of apps and those who had used apps on the SUS. This mean difference shows that those who had never used an app were automatically decreasing their usability score on the SUS by 38.75, a statistically significant result (p value = 0.033).

The two sample t test also showed a mean difference of -23.875 between the two groups on their global SUMI score. This again was a significant result (p value 0.022) that shows that the participants with no previous use of apps decreased their global SUMI usability score by 23.875. The SUMI efficiency subscale measures the how much the participants felt the VRA assisted them in their rehabilitation and based on the result of the two sample t test, the participants with no previous use of apps decreased their efficient use of the app by 27 points on the SUMI efficiency scale, a statistically significant result (p value = 0.031). The SUMI affect subscale measures the user's general emotional reaction to the VRA and the two sample t test showed a decrease in likeability of VRA by 22.75 points on the SUMI affect scale in those with no previous use of apps. Helpfulness

measures how self-explanatory the software is. In participants with no previous use of apps, they scored 15.88 points less on this scale, an insignificant result ( $p$  value = 0.127). Controllability relates to how much control the participants had over the VRA, as opposed to being controlled by the app itself. Here a statistically significant result ( $p$  value = 0.014) showed that those with no previous use of apps scored 21.5 points less on this scale, showing that they felt controlled by VRA. Lastly learnability measure how well the participants could master the app. Despite those without apps decreasing their “mastery” of the app by 23 points on the scale, this result was not statistically significant ( $p$  value = 0.066).

The use of apps showed significant results in terms of usability and these results coincide with Sum et al (2009). Sum et al (2009) found that technology was predominantly reserved for gathering information about online purchases and keeping in contact with friends and relatives who were not living locally in older adults (over 55). There was no mention of exercise or rehabilitation use through technology. With such as the case, previous use of technology may not be beneficial in terms of the VRA as this was a completely new setting and environment for all participants.

Blit-Cohen and Litwin (2004) also found that elderly people with no previous use of technology were reluctant to use technology. This was reflected in the VRA study where those with no previous use of apps were more likely to report increased adherence with their original paper-based exercises. These participants reported the VRA altered their routine which was an inconvenience.

#### **4.5 Training Time**

Training time was defined as the amount of time it took to train each participant in the use of the tablet and VRA. Training was standardised however participants were allowed to ask questions throughout which would lengthen the training time.

There were strong negative correlations between usability and training time as measured on the SUMI global score and SUS. This translates to an increased training time results in decreased usability of the VRA. This relationship was further quantified where unstandardised coefficient  $B = -0.114$ . This means that for every one second increase in training, there was a 0.11% decrease in usability. For every one minute increase in training, a 6.6% decrease in usability was seen. This has huge implications for clinical practice whereby if a patient exceeds ten minutes of training time, combined with their age and previous use of apps, their usability is likely to decrease and the VRA may not be the most appropriate treatment for that patient. Although training time presents as the biggest predictor of usability, care must be taken when interpreting this as the other two significant results (age and use of apps) had a decreased sample size due to separation into groups whereas training time had the required sample size for analysis.

#### **4.6 Levels of Dizziness**

In terms of level of dizziness, the null hypothesis must be accepted as there was no linear relationship between DHI and SUS ( $r = -0.019$ ) and a weak positive relationship between VAS for dizziness and SUS ( $r = 0.268$ ). This shows that despite increased dizziness as measured on the VAS or DHI, the participants can still use the VRA. High irritability does not result in decreased usability which rejects the hypothesis that increased dizziness would result in decreased usability.

This was replicated in the SUMI where there was a moderate positive relationship between global score and all subscales with DHI except the subscale helpfulness. Similarly the DHI and SUMI showed no linear relationship while there was a weak negative correlation between helpfulness and DHI. The VAS results were also similar where there was a weak positive correlation between global SUMI score and all subscales. This again highlights that the level of dizziness experienced by the patient will not affect their usability on the VRA. This coincides with previous research by Meldrum et al (2011) where high levels of usability of technology (average SUS score of 82) in 26 participants with balance and vestibular dysfunction were reported. This study looked at the usability of the Nintendo Wii® and found that there was a high level of usability and enjoyment among the participants despite their balance impairments.

#### **4.7 Usability**

Effectiveness is defined by the ISO (1998) as “the accuracy and completeness with which specified users can achieve specific goals in particular environments”. This meant that participants were undergoing vestibular rehabilitation in a technological environment and their ability to complete their daily adaptation exercises was being assessed. Overall eight of the 12 participants were effective in their use of VRA and could carry out their exercises as if they were their original exercises. However this did not translate into increased adherence to VRA where only 33% (n=4) of the participants reported increased compliance with VRA. They felt that the majority of this compliance was as a result of having a electronic tablet on their table to remind them of the exercises. It decreased paper work and the effort of finding a sheet of paper to write out the letter “E”. The remaining participants felt that VRA was too complicated for everyday use

and that it disrupted their routine. There was also an element of ageism whereby 33% (n=4) of the participants felt that age was a barrier to use of VRA. This coincides with Blit-Cohen and Litwin (2004) who reported that elderly adults with no previous use of technology blame their age for decreased usability of technology.

Efficiency is defined as “the resources expended in relation to the accuracy and completeness of goals achieved” (ISO, 1998). This translates as the effort it took each participant to complete an exercise on VRA. Ten of the 12 participants felt comfortable using the app and did not notice any increased dizziness compared to the original paper based exercises. However those that felt uncomfortable (n=2) with VRA felt it was due to an increase in duration of exercise (from 30 seconds on paper to 1 minute on VRA) or as a result of their fear of technology. This fear was prevalent, particularly in the over 65s groups. There was a definite learning curve identified with the app whereby participants improved as the week went on as they used VRA more. However there was still an element that unfamiliarity caused inefficiency with VRA.

Convenience was another strong theme throughout the interviews with an overall consensus that VRA was inconvenient. These results should be interpreted carefully however as the under 65s group felt it was the electronic tablet that VRA was on that caused the inconvenience due to the bulkiness and change in routine. The under 65s felt that VRA would be more accessible, transportable and discreet on a smartphone instead of a tablet. However the over 65s generally felt that VRA caused too much disruption to their original exercise routine and was an

inconvenience therefore they remained more adherent to the original paper exercises.

Satisfaction is defined as the comfort and acceptability of the work system (ISO, 1998). In general this relates to the participants' likeability of VRA and whether they would use it again. Just over half of the participants (n=7) preferred the original paper based exercises, five of which were over 65, showing decreased satisfaction with VRA however when asked would they have any issue with using VRA again, only two participants reported they would not like to use it for rehabilitation in the future.

Hart et al (2008) evaluated websites designed for older adults in terms of how well they adhere to 'senior-friendly' guidelines ([www.nihseniorhealth.gov/](http://www.nihseniorhealth.gov/)) and overall ease of use and satisfaction. Hart et al (2008) found that the website most compliant with the 'senior-friendly' guidelines resulted in higher task success, but did not result in significantly better efficiency, satisfaction, or preference. These findings demonstrate the importance of using both guidelines and usability testing when designing websites for older adults. This coincides with the VRA study, where although the average SUS overall was 68.96, which is just above the cut-off score for above average usability of 68 (Lewis and Sauro, 2009), there are still elements of the VRA that were user-friendly. It is obvious from the average SUMI scores that the areas that need most improvement are efficiency (mean score = 47), controllability (mean score = 47.58) and learnability (mean score = 47.58) as these subscales scored the least overall. The decrease in efficiency shows that participants found the app disrupted their normal routine and therefore designers should take note of the participants' recommendations to improve discretion and accessibility by providing the option

of having VRA on a smartphone. This would allow the participant to access the VRA at any time, encouraging them to incorporate the app, as opposed to the tablet, as part of their routine. The decrease in controllability shows how participants felt that they were being controlled by the VRA. In order to rectify this perhaps more input from the participant should be allowed such as duration of exercise and background colour. Similarly one participant felt that the VRA should incorporate an alarm system, whereby the participant could set an alarm through the app to remind them to do their exercises. The decrease in learnability highlights the definite learning curve involved with VRA. This would suggest that participants should have more exposure to VRA before using it independently without their treating physiotherapist. Continued use in treatment sessions before recommending the VRA as a home exercise programme may reverse this.

#### **4.8 Limitations of Study**

There were several limitations of this study. It was initially hoped to compare reported adherence to the exercises with actual adherence (as measured on VRA by number of exercises completed). However due to VRA being a prototype, unfortunately the record of exercises completed on two of the three tablets did not correlate with what participants had actually completed. Poor adherence to physiotherapy is a problem with up to 65% of patients being either non-adherent or partially adherent to their home exercise programmes, and approximately 10% of patients failing to complete their prescribed course of physiotherapy (Bassett, 2003). Similarly Huang et al (2014) reported under-compliance in over half of their participants with iPod based balance exercises. It would have been interesting to see if adherence rates of VRA correlated with both of these studies as VRA was a very different form of physiotherapy treatment.



Another limitation was the standardisation of training. Although the principal investigator followed a script, each training session was different subjectively as each participant asked different questions. Although the principal investigator attempted to standardise the training, it was difficult with varying levels of ability with the participants. However, despite the possible lack of standardisation, the training time recorded can be taken as a rough guide for each participant's learnability.

Sample size was another limitation. Both quantitative outcome measures required at least 12 participants and although sample size was  $n=12$ , the sample was split for certain analyses. When the participants were split into previous use of apps versus no previous use of apps, the analysis was done with a sample size of less than 12, therefore results should be carefully interpreted.

As with all cross sectional studies, selection bias is a risk. Sampling was done by convenience with no randomisation, thus increasing the risk of selection bias. Similarly confounding bias may have occurred as there were three significant variables found in this study that may have interacted with each other's results

#### **4.9 Recommendations for Further Research**

These recommendations should be implemented into future studies of the VRA

- Recruitment of a larger sample size to adequately power various groups to allow statistically significant results which are clinically meaningful.
- Further standardisation of training in the use of VRA.
- The usability of electronic tablets and usability of the VRA should be investigated separately to ensure differentiation of the two types of technology.

- Adherence and compliance should be measured and compared to participants' reported level of compliance.
- Future studies should involve a follow-up period where another post intervention assessment could take place three months later. This may provide useful information on the carry-over of the VRA treatment.
- The effectiveness of the VRA should be compared to paper-based exercises to determine if one form of exercise is more effective than the other.

Inclusion of these recommendations in further research would determine whether the VRA is an appropriate treatment for patients with decreased dynamic visual acuity.

#### **4.10 Summary**

In summary, age, previous use of apps and the length of time it takes to train a patient in the use of VRA all affected participants' usability. Age in fact aided in predicting their usability. If the patient was over 65, their usability was likely to decrease.

Irritability of symptoms shows no correlation with usability meaning that regardless of the level of dizziness, the VRA can still be used effectively

Overall, effective use of the VRA was affected by age and decreased adherence. This decreased adherence was as a result of inconvenience and altered routine. Efficient use of the app was limited by unfamiliarity and fear with participants identifying a definite learning curve when using it. Satisfaction was divided with participants making key recommendations that should be followed through with

the app, however the majority of participants had high levels of comfort with the VRA and would be agreeable to using it again.

## CONCLUSION

The original hypothesis that there would be a negative correlation between age and usability was accepted. Specifically each one year increase in age resulted in 0.5% decrease in usability.

The original hypothesis of increased dizziness would equal decreased usability was rejected as there was no correlation between level of dizziness and usability. An increase on the VAS was actually associated with an increase in usability on the VRA.

However it was not expected that training time or previous use of apps would show strong correlations with usability. Once training time exceeds ten minutes, usability will be below average while previous use of apps will increase usability by 46%. However sample size may have influenced these results as training time was the only variable with the required number of participants for statistical analysis.

Age appeared to be a barrier for effective use of the VRA while the inconvenience of the tablet and altered routine resulted in decreased adherence to the VRA.

Participants felt more in control of the app with the more exposure they had to it while the majority of participants reported high levels of comfort with the VRA. Just over half of the participants preferred the original paper-based exercises however the majority would be open to using the VRA again in the future.

Larger scale studies are warranted to determine whether training time is in fact the biggest predictor of usability. Similarly a comparison between paper-based adaptation exercises and VRA exercises should be investigated to determine which form is more effective at improving dynamic visual acuity.

**Word Count:** 12,301

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## APPENDICES

### 1.1 SUS

#### ***System Usability Scale***

© Digital Equipment Corporation, 1986.

	Strongly disagree							Strongly agree
• I think that I would like to use this system frequently	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
	1	2	3	4	5			
• I found the system unnecessarily complex	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
	1	2	3	4	5			
• I thought the system was easy to use	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
	1	2	3	4	5			
• I think that I would need the support of a technical person to be able to use this system	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
	1	2	3	4	5			
• I found the various functions in this system were well integrated	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
	1	2	3	4	5			
• I thought there was too much inconsistency in this system	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
	1	2	3	4	5			
• I would imagine that most people would learn to use this system very quickly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
	1	2	3	4	5			
• I found the system very cumbersome to use	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
	1	2	3	4	5			
• I felt very confident using the system	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
	1	2	3	4	5			
• I needed to learn a lot of things before I could get going with this system	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
	1	2	3	4	5			



## ***Using SUS***

The SU scale is generally used after the respondent has had an opportunity to use the system being evaluated, but before any debriefing or discussion takes place. Respondents should be asked to record their immediate response to each item, rather than thinking about items for a long time.

All items should be checked. If a respondent feels that they cannot respond to a particular item, they should mark the centre point of the scale.

## ***Scoring SUS***

SUS yields a single number representing a composite measure of the overall usability of the system being studied. Note that scores for individual items are not meaningful on their own.

To calculate the SUS score, first sum the score contributions from each item. Each item's score contribution will range from 0 to 4. For items 1,3,5,7, and 9 the score contribution is the scale position minus 1. For items 2,4,6,8 and 10, the contribution is 5 minus the scale position. Multiply the sum of the scores by 2.5 to obtain the overall value of SU.

SUS scores have a range of 0 to 100.

The following section gives an example of a scored SU scale.

## System Usability Scale

© Digital Equipment Corporation, 1986.

	1	2	3	4	5	
	<div style="display: flex; justify-content: space-between; border: 1px solid black; padding: 2px;"> <span>Strongly disagree</span> <span></span> <span></span> <span></span> <span>Strongly agree</span> </div>					1
1 I think that I would like to use this system frequently	<div style="display: flex; justify-content: space-between; border: 1px solid black; padding: 2px;"> <span></span> <span></span> <span></span> <span></span> <span></span> </div>					1
2 I found the system unnecessarily complex	<div style="display: flex; justify-content: space-between; border: 1px solid black; padding: 2px;"> <span>1</span> <span>2</span> <span>3</span> <span>4</span> <span>5</span> </div>					
3 I thought the system was easy to use	<div style="display: flex; justify-content: space-between; border: 1px solid black; padding: 2px;"> <span></span> <span></span> <span></span> <span></span> <span></span> </div>					4
4 I think that I would need the support of a technical person to be able to use this system	<div style="display: flex; justify-content: space-between; border: 1px solid black; padding: 2px;"> <span>1</span> <span>2</span> <span>3</span> <span>4</span> <span>5</span> </div>					1
5 I found the various functions in this system were well integrated	<div style="display: flex; justify-content: space-between; border: 1px solid black; padding: 2px;"> <span></span> <span></span> <span></span> <span></span> <span></span> </div>					2
6 I thought there was too much inconsistency in this system	<div style="display: flex; justify-content: space-between; border: 1px solid black; padding: 2px;"> <span></span> <span></span> <span></span> <span></span> <span></span> </div>					1
7 I would imagine that most people would learn to use this system very quickly	<div style="display: flex; justify-content: space-between; border: 1px solid black; padding: 2px;"> <span>1</span> <span>2</span> <span>3</span> <span>4</span> <span>5</span> </div>					1
8 I found the system very cumbersome to use	<div style="display: flex; justify-content: space-between; border: 1px solid black; padding: 2px;"> <span></span> <span></span> <span></span> <span></span> <span></span> </div>					4
9 I felt very confident using the system	<div style="display: flex; justify-content: space-between; border: 1px solid black; padding: 2px;"> <span>1</span> <span>2</span> <span>3</span> <span>4</span> <span>5</span> </div>					
10 I needed to learn a lot of things before I could get going with this system	<div style="display: flex; justify-content: space-between; border: 1px solid black; padding: 2px;"> <span></span> <span></span> <span></span> <span></span> <span></span> </div>					3

**Total score = 22**

**SUS Score = 22 \*22.5 = 55**

## 1.2 SUMI

### SOFTWARE USABILITY MEASUREMENT INVENTORY

(SUMI)

Your name .....

Name of software .....

Date .....

**NB** the information you provide is kept completely confidential, and no information is stored on computer media that could identify you as a person.

This inventory has fifty statements. Please answer every one of them. Against each statement there are three boxes.

You should mark the first box if you generally AGREE with the statement. Mark the central box if you are UNDECIDED, can't make up your mind, or if the statement has no relevance to your software or to your situation. Mark the right box if you generally DISAGREE with the statement.

In marking the left or right box you are not necessarily indicating *strong* agreement or disagreement but just your general feeling most of the time.

AGREE UNDECIDED DISAGREE

Put a ☺ mark in the box of your choice.

Disagree  
Undecided  
Agree  
D D D

- This software responds too slowly to inputs. • ^ ^
- I would recommend this software to my colleagues. • ^ ^
- The instructions and prompts are helpful. • ^ ^
- The software has at some time stopped unexpectedly. • ^ ^
- Learning to operate this software initially is full of problems. • ^ ^
- I sometimes don't know what to do next with this software. • ^ ^
- I enjoy my sessions with this software. • ^ ^
- I find that the help information given by this software is not very useful. • ^ ^
- If this software stops, it is not easy to restart it. • ^ ^
- It takes too long to learn the software commands. • ^ ^
- I sometimes wonder if I'm using the right command. • ^ ^
- Working with this software is satisfying. • ^ ^
- The way that system information is presented is clear and understandable. • ^ ^
- I feel safer if I use only a few familiar commands or operations. • ^ ^
- The software documentation is very informative. • ^ ^
- This software seems to disrupt the way I normally like to arrange my work. • ^ ^
- Working with this software is mentally stimulating. • ^ ^
- There is never enough information on the screen when it's needed. • ^ ^
- I feel in command of this software when I am using it. • ^ ^
- I prefer to stick to the facilities that I know best. • ^ ^

Disagree  
Undecided  
Agree  
D D D

- 11 I think this software is inconsistent. ^ ^ ^
- 12 I would not like to use this software every day. ^ ^ ^
- 13 I can understand and act on the information provided by this software. ^ ^ ^
- 14 This software is awkward when I want to do something which is not standard. ^ ^ ^
- 15 There is too much to read before you can use the software. ^ ^ ^
- 16 Tasks can be performed in a straightforward manner using this software. ^ ^ ^
- 17 Using this software is frustrating. ^ ^ ^
- 18 The software has helped me overcome any problems I have had in using it. ^ ^ ^
- 19 The speed of this software is fast enough. ^ ^ ^
- 20 I keep having to go back to look at the guides. ^ ^ ^
- 21 It is obvious that user needs have been fully taken into consideration. ^ ^ ^
- 22 There have been times in using this software when I have felt quite tense. ^ ^ ^
- 23 The organisation of the menus or information lists seems quite logical. ^ ^ ^
- 24 The software allows the user to be economic of keystrokes. ^ ^ ^
- 25 Learning how to use new functions is difficult. ^ ^ ^
- 26 There are too many steps required to get something to work. ^ ^ ^
- 27 I think this software has made me have a headache on occasion. ^ ^ ^
- 28 Error prevention messages are not adequate. ^ ^ ^
- 29 It is easy to make the software do exactly what you want. ^ ^ ^
- 40 I will never learn to use all that is offered in this software. ^ ^ ^

*Please continue overleaf*

Disagree  
Undecided  
Agree  
D D D

- 41 The software hasn't always done what I was expecting. ^ ^ ^
- 42 The software has a very attractive presentation. ^ ^ ^
- 43 Either the amount or quality of the help information varies across the system. ^ ^ ^
- 44 It is relatively easy to move from one part of a task to another. ^ ^ ^
- 45 It is easy to forget how to do things with this software. ^ ^ ^
- 46 This software occasionally behaves in a way which can't be understood. ^ ^ ^
- 47 This software is really very awkward. ^ ^ ^
- 48 It is easy to see at a glance what the options are at each stage. ^ ^ ^
- 49 Getting data files in and out of the system is not easy. ^ ^ ^
- 50 I have to look for assistance most times when I use this software. ^ ^ ^

*Please check you have ticked each item.*  
*Thank you.*

## 2.1 Montreal Cognitive Assessment (MoCA)

### Montreal Cognitive Assessment (MoCA)

#### Administration and Scoring Instructions

The Montreal Cognitive Assessment (MoCA) was designed as a rapid screening instrument for mild cognitive dysfunction. It assesses different cognitive domains: attention and concentration, executive functions, memory, language, visuoconstructional skills, conceptual thinking, calculations, and orientation. Time to administer the MoCA is approximately 10 minutes. The total possible score is 30 points; a score of 26 or above is considered normal.

#### 1. Alternating Trail Making:

Administration: The examiner instructs the subject: *"Please draw a line, going from a number to a letter in ascending order. Begin here [point to (1)] and draw a line from 1 then to A then to 2 and so on. End here [point to (E)]."*

Scoring: Allocate one point if the subject successfully draws the following pattern:

1 –A- 2- B- 3- C- 4- D- 5- E, without drawing any lines that cross. Any error that is not immediately self-corrected earns a score of 0.

#### 2. Visuoconstructional Skills (Cube):

Administration: The examiner gives the following instructions, pointing to the **cube**: *"Copy this drawing as accurately as you can, in the space below".*

Scoring: One point is allocated for a correctly executed drawing.

- Drawing must be three-dimensional
- All lines are drawn
- No line is added
- Lines are relatively parallel and their length is similar (rectangular prisms are accepted)

A point is not assigned if any of the above-criteria are not met.

#### 3. Visuoconstructional Skills (Clock):

Administration: Indicate the right third of the space and give the following instructions: *"Draw a clock. Put in all the numbers and set the time to 10 past 11".*

Scoring: One point is allocated for each of the following three criteria:

- Contour (1 pt.): the clock face must be a circle with only minor distortion acceptable (e.g., slight imperfection on closing the circle);
- Numbers (1 pt.): all clock numbers must be present with no additional numbers; numbers must be in the correct order and placed in the approximate quadrants on the clock face; Roman numerals are acceptable; numbers can be placed outside the circle contour;
- Hands (1 pt.): there must be two hands jointly indicating the correct time; the hour hand must be clearly shorter than the minute hand; hands must be centred within the clock face with their junction close to the clock centre.

A point is not assigned for a given element if any of the above-criteria are not met.



#### 4. Naming:

Administration: Beginning on the left, point to each figure and say: *“Tell me the name of this animal”*.

Scoring: One point each is given for the following responses: (1) lion (2) rhinoceros or rhino (3) camel or dromedary.

#### 5. Memory:

Administration: The examiner reads a list of 5 words at a rate of one per second, giving the following instructions: *“This is a memory test. I am going to read a list of words that you will have to remember now and later on. Listen carefully. When I am through, tell me as many words as you can remember. It doesn’t matter in what order you say them”*.

Mark a check in the allocated space for each word the subject produces on this first trial. When the subject indicates that (s)he has finished (has recalled all words), or can recall no more words, read the list a second time with the following instructions: *“I am going to read the same list for a second time. Try to remember and tell me as many words as you can, including words you said the first time.”* Put a check in the allocated space for each word the subject recalls after the second trial.

At the end of the second trial, inform the subject that (s)he will be asked to recall these words again by saying, *“I will ask you to recall those words again at the end of the test.”*

Scoring: No points are given for Trials One and Two.

#### 6. Attention:

Forward Digit Span: Administration: Give the following instruction: *“I am going to say some numbers and when I am through, repeat them to me exactly as I said them”*. Read the five number sequence at a rate of one digit per second.

Backward Digit Span: Administration: Give the following instruction: *“Now I am going to say some more numbers, but when I am through you must repeat them to me in the backwards order.”* Read the three number sequence at a rate of one digit per second.

Scoring: Allocate one point for each sequence correctly repeated, (*N.B.*: the correct response for the backwards trial is 2-4-7).

Vigilance: Administration: The examiner reads the list of letters at a rate of one per second, after giving the following instruction: *“I am going to read a sequence of letters. Every time I say the letter A, tap your hand once. If I say a different letter, do not tap your hand”*.

Scoring: Give one point if there is zero to one errors (an error is a tap on a wrong letter or a failure to tap on letter A).

Serial 7s: Administration: The examiner gives the following instruction: *“Now, I will ask you to count by subtracting seven from 100, and then, keep subtracting seven from your answer until I tell you to stop.”* Give this instruction twice if necessary.

Scoring: This item is scored out of 3 points. Give no (0) points for no correct subtractions, 1 point for one correction subtraction, 2 points for two-to-three correct subtractions, and 3 points if the participant successfully makes four or five correct subtractions. Count each correct subtraction of 7 beginning at 100. Each subtraction is evaluated independently; that is, if the participant responds with an incorrect number but continues to correctly subtract 7 from it, give a point for each correct subtraction. For example, a participant may respond “92 – 85 – 78 – 71 – 64” where the “92” is incorrect, but all subsequent numbers are subtracted correctly. This is one error and the item would be given a score of 3.

## 7. Sentence repetition:

Administration: The examiner gives the following instructions: *“I am going to read you a sentence. Repeat it after me, exactly as I say it [pause]: **I only know that John is the one to help today.**”* Following the response, say: *“Now I am going to read you another sentence. Repeat it after me, exactly as I say it [pause]: **The cat always hid under the couch when dogs were in the room.**”*

Scoring: Allocate 1 point for each sentence correctly repeated. Repetition must be exact. Be alert for errors that are omissions (e.g., omitting “only”, “always”) and substitutions/additions (e.g., “John is the one who helped today;” substituting “hides” for “hid”, altering plurals, etc.).

## 8. Verbal fluency:

Administration: The examiner gives the following instruction: *“Tell me as many words as you can think of that begin with a certain letter of the alphabet that I will tell you in a moment. You can say any kind of word you want, except for proper nouns (like Bob or Boston), numbers, or words that begin with the same sound but have a different suffix, for example, love, lover, loving. I will tell you to stop after one minute. Are you ready? [Pause] Now, tell me as many words as you can think of that begin with the letter F. [time for 60 sec]. Stop.”*

Scoring: Allocate one point if the subject generates 11 words or more in 60 sec. Record the subject’s response in the bottom or side margins.

## 9. Abstraction:

Administration: The examiner asks the subject to explain what each pair of words has in common, starting with the example: *“Tell me how an orange and a banana are alike”*. If the subject answers in a concrete manner, then say only one additional time: *“Tell me another way*

*in which those items are alike*". If the subject does not give the appropriate response (*fruit*), say, "Yes, and they are also both *fruit*." Do not give any additional instructions or clarification. After the practice trial, say: "Now, tell me how a train and a bicycle are alike". Following the response, administer the second trial, saying: "Now tell me how a ruler and a watch are alike". Do not give any additional instructions or prompts.

**Scoring:** Only the last two item pairs are scored. Give 1 point to each item pair correctly answered. The following responses are acceptable:

Train-bicycle = means of transportation, means of travelling, you take trips in both; Ruler-watch = measuring instruments, used to measure.

The following responses are **not** acceptable: Train-bicycle = they have wheels; Ruler-watch = they have numbers.

## 10. **Delayed recall:**

**Administration:** The examiner gives the following instruction: *“I read some words to you earlier, which I asked you to remember. Tell me as many of those words as you can remember.”* Make a check mark ( ✓ ) for each of the words correctly recalled spontaneously without any cues, in the allocated space.

**Scoring:** Allocate 1 point for each word recalled freely without any cues.

### **Optional:**

Following the delayed free recall trial, prompt the subject with the semantic category cue provided below for any word not recalled. Make a check mark ( ✓ ) in the allocated space if the subject remembered the word with the help of a category or multiple-choice cue. Prompt all non-recalled words in this manner. If the subject does not recall the word after the category cue, give him/her a multiple choice trial, using the following example instruction, *“Which of the following words do you think it was, NOSE, FACE, or HAND?”*

Use the following category and/or multiple-choice cues for each word, when appropriate:

FACE: category cue: part of the body

multiple choice: nose, face, hand

VELVET: category cue: type of fabric

multiple choice: denim, cotton, velvet

CHURCH: category cue: type of building

multiple choice: church, school, hospital

DAISY: category cue: type of flower

multiple choice: rose, daisy, tulip

RED: category cue: a colour

multiple choice: red, blue, green

**Scoring:** No points are allocated for words recalled with a cue. A cue is used for clinical information purposes only and can give the test interpreter additional information about the type of memory disorder. For memory deficits due to retrieval failures, performance can be improved with a cue. For memory deficits due to encoding failures, performance does not improve with a cue.

## 11. **Orientation:**

**Administration:** The examiner gives the following instructions: *“Tell me the date today”*. If the subject does not give a complete answer, then prompt accordingly by saying: *“Tell me the [year, month, exact date, and day of the week].”* Then say: *“Now, tell me the name of this place, and which city it is in.”*

**Scoring:** Give one point for each item correctly answered. The subject must tell the exact date and the exact place (name of hospital, clinic, office). No points are allocated if subject makes an error of one day for the day and date.

**TOTAL SCORE:** Sum all subscores listed on the right-hand side. Add one point for an individual who has 12 years or fewer of formal education, for a possible maximum of 30 points. A final total score of 26 and above is considered normal.

## **2.2 Patient Invitation Letter**

### **PATIENT INVITATION LETTER**

#### **Study Title: Assessing the Usability of an Electronic Application for Vestibular Rehabilitation**

We are writing to invite you to participate in a research study. We are approaching you because you have a condition that affects your dizziness and balance

The physiotherapist looking after you has provided you with specific exercises that should improve your vision while walking or moving your head. However these exercises are often difficult to progress and can often be somewhat boring which is why new methods of doing these exercises are being investigated.

The Principal Investigator for this study is Patricia Hassett, a physiotherapist based in the Midlands Regional Hospital, Tullamore, Co. Offaly.

Before you decide if you would like to take part in this study, please would you take the time to read the enclosed Information Sheet.

With your permission, your treating nurse/ physiotherapist will give your contact details to the study team, where the principal investigator will contact you within the next few days to discuss the study and answer any questions. This information will be kept strictly confidential within the team. If you are interested in this study we will make an appointment to see you. If you decide you are not interested in this study, this will not affect your normal care in any way. If you would like more information about the study, please do not hesitate to contact the principal investigator on 0860701358 (after 5pm) or at [patriciahassett@rcsi.ie](mailto:patriciahassett@rcsi.ie).

Thank you very much for taking the time to read this information.

Yours sincerely,

Patricia Hassett

## RESEARCH PARTICIPANT INFORMATION LEAFLET

**(Version: 1      Date: 8/8/2015)**

**Principal investigator's name:** Patricia Hassett

**Telephone number of principal investigator:** 0860701358

**Co-investigator's title:** **Academic Supervisor**

Before you decide whether or not you wish to take part, you should read the information provided below carefully and, if you wish, discuss it with your family, friends or GP (doctor). Take time to ask questions – do not feel rushed or under pressure to make a quick decision.

You should clearly understand the risks and benefits of taking part in this study so that you can make a decision that is right for you. This process is known as 'Informed Consent'.

You do not have to take part in this study and a decision not to take part will not effect on your future medical care.

You can change your mind about taking part in the study any time you like. Even if the study has started, you can still opt out. You do not have to give us a reason. If you do opt out, it will not affect the quality of treatment you get in the future.

**Why is this study being done?**

This study is taking place in order to see how user-friendly a smartphone application is in the treatment of some common symptoms in inner ear and neurological conditions along with aging. The smartphone "app" will involve exercises for eye movement that aim to improve how well you can focus your vision when your head is moving. This study is taking place in order to see if patients can use this "app" in place of their usual exercises

**Who is organising and funding this study?**

Patricia Hassett is both organising and funding this study as part of her MSc qualification from the Royal College of Surgeons, Ireland (RCSI). Dr. Dara Meldrum of RCSI will supervise the project. Patricia is not receiving a grant nor is she receiving any form of payment for carrying out this study

**Why am I being asked to take part?**

You are being asked to take part in this study because you have a condition that affects your balance and dizziness. You also attend this hospital for your vestibular rehabilitation which is why you are being included in this particular study.



**How will the study be carried out?**

The study will take place between October and December in Midlands Regional Hospital, Tullamore, however you will only be in the study for one week and then you will be finished. It is hoped to have 24 participants in the study. These participants can expect the same type of exercises for your dizziness, but just on an electronic tablet

**What will happen to me if I agree to take part?**

You will be trained in the use of the tablet “app” by Patricia. You will then take the tablet home for one week and complete your exercises using the tablet. You won’t be missing out on any exercises nor will you have to attend for an extra visit, it will still be the same as your usual treatment except it will be on a tablet. When you come back after one week you will take part in an interview with Patricia to get your opinions on the app. This interview will be recorded on a tape recorder, however you have the permission not to consent to this. You will also fill out two short questionnaires, altogether it should take about 30 minutes. You may experience some dizziness with the exercises however you will more than likely have experienced this with your other exercises as well. Patricia will have access to your medical records as your treating physiotherapist but there should be no need for your medical records for the study.

**What other treatments are available to me?**

If you do not want to participate, you will continue with your usual vestibular rehabilitation.

**What are the benefits?**

You may find your dizziness and blurred vision improving but overall the aim of the study is to see if tablets can be used for vestibular rehabilitation, it is not directly going to have an effect on your health.

**What are the risks?**

You may experience dizziness and unsteadiness with the exercises but you will complete them in sitting which will reduce your risk of falling. It should not add any extra workload onto your day, the amount of exercises will be similar to that which you were doing beforehand.

**What if something goes wrong when I’m taking part in this study?**

You have the right to drop out at any stage without giving a reason.

**Will it cost me anything to take part?**

No the study will not cost you anything. You will have to sign an agreement for borrowing the tablet for the week. You will also not receive any payment for completing this study

**Is the study confidential?**

Yes the study is confidential. Your name will be coded and Patricia will be the only researcher with the key to the code. Patricia will need to access your medical records in order to get the diagnosis (if there is one available) for your dizziness. Information about you will be kept until the study has been published however it will remain coded and non-identifiable and will be saved to a password protected USB key. Any audio or paper evidence will be destroyed after all documents have been computerised.

You are fully entitled to get your results from the study, please ensure you mention this to the principal investigator (Patricia). It is anticipated that this study will be published however there will be no identifying information about you.

None of the data will be kept for future studies either

**Where can I get further information?**

If you have any further questions about the study or if you want to opt out of the study, you can rest assured it won't affect the quality of treatment you get in the future.

If you need any further information now or at any time in the future, please contact:

Patricia Hassett

Main St., Templetuohy

Thurles, Co. Tipperary

0860701358 (after 5pm)

## 2.4 Consent Form

PATIENT CONSENT FORM (Version: 1      Date: 8/8/2015)

Title of Study:

<i>I have read and understood the <b>Information Leaflet</b> about this research project. The information has been fully explained to me and I have been able to ask questions, all of which have been answered to my satisfaction.</i>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
<i>I understand that I don't have to take part in this study and that I can opt out at any time. I understand that I don't have to give a reason for opting out and I understand that opting out won't affect my future medical care.</i>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
<i>I am aware of the potential risks of this research study.</i>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
<i>I give permission for researchers to look at my GP or hospital medical records to get information. I have been assured that information about me will be kept private and confidential.</i>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
<i>I understand that an audio/and or video recording will be made and that I have the right to review and edit any transcripts to which I have contributed.</i>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
<i>I have been given a copy of the Information Leaflet and this completed consent form for my records.</i>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
<b>Storage and future use of information:</b> <i>I give permission for material/data to be stored for possible future research:</i> (a) related to the current study subject to research ethics committee approval (b) related to the current study only if consent is obtained at the time of the future research subject to research ethics committee approval.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
<i>I give permission for material/data to be stored for possible future research related to the current study without further consent being required subject to research ethics committee approval.</i>	yes <input type="checkbox"/>	no <input type="checkbox"/>
<i>I give permission for material/data to be stored for possible future research:</i> (a) unrelated to the current study subject to research ethics committee approval (b) unrelated to the current study only if consent is obtained at the time of the future research subject to research ethics committee approval.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
<i>I give permission for material/data to be stored for possible future research unrelated to the current study without further consent being required subject to research ethics committee approval.</i>	yes <input type="checkbox"/>	no <input type="checkbox"/>

Participant Name (Block Capitals): \_\_\_\_\_

Participant Signature: \_\_\_\_\_ Date: \_\_\_\_\_

**To be completed by the Principal Investigator or his nominee.**

I the undersigned have taken the time to fully explain to the above patient the nature and purpose of this study in a manner that they could understand. I have explained the risks involved as well as

the possible benefits. I have invited them to ask questions on any aspect of the study that concerned them.

**Name & Qualifications (Block Capitals):** \_\_\_\_\_

**Signature:** \_\_\_\_\_ **Date:** \_\_\_\_\_

3 copies to be made: 1 for patient, 1 for PI and 1 for practice records (if relevant).

## 2.5 Common Data Form

### Common Data Entry Form

<b>Subject ID</b>	
<b>Diagnosis</b>	
<b>DVAT Score</b>	
<b>VRA Login and Password</b>	
<b>Age</b>	
<b>DHI Score</b>	
<b>VAS for Dizziness</b>	
<b>Time taken to complete training</b>	
<b>SUS Score</b>	
<b>Tablet Used</b>	
<b>Number of Exercises Completed</b>	

## 2.6 Ethics Statement from SUMI

### Ethics Statement SUMI Scale at University College Cork

How SUMI and WAMMI data is handled at UCC Computer Centre

Notes by Jurek Kirakowski on the basis of information provided by the Manager of the Computer Centre Electronic Publishing Unit, Peter Flynn.

#### Summary:

No identifiable personal data or high-level security information may be gathered by application scripts or web forms running on the main web server at the Computer Centre at UCC. The SUMI and WAMMI questionnaires are permitted under this policy. Data submitted by the web forms is available to a limited number of technical staff at the Computer Centre who nevertheless are unable to interpret the meaning of the data without seeing the web form script. The data in its originating format is deleted after nine weeks. The data is also transformed into XML format and it is held in this format at UCC's Computer Centre indefinitely. Web form data from SUMI and WAMMI pages is forwarded immediately to the HFRG. At the HFRG the data is stripped of its originating URI information at the first stage of processing. After a report has been generated and transmitted to the client who commissioned the survey, the attribution of SUMI and WAMMI numeric responses to a specific client is also stripped, as is any data provided in response to additional questions. The numeric data alone are kept indefinitely at HFRG without reference to any individual or any specific client.

#### Notes:

It's always been a paradoxical embarrassment that data on the Internet -- indeed data on computers in general -- is subject \*at the same time\* to the risk of deletion forever (by accident, neglect, or malice) as well as to the risk of preservation in perpetuity (by design, and sometimes by accident or even malice).

University College Cork (UCC) runs a public shared web server using normal HTTP (protocol.) Normal HTTP should not be used for identifiable personal data where there are security considerations (eg home address, medical data, bank accounts.) If an application is going to involve identifiable personal data or high-level security information then the Computer Bureau at UCC does not allow the application script or data to run on the main web server.

The questions in the WAMMI and SUMI questionnaires, as well as the standard additional questions, are not regarded as a high-level security risk nor do they provide identifiable personal data.

UCC Computer Centre keeps logs of every questionnaire form submitted.

- a. The transaction is recorded in the standard Apache log file as a single line with the date, requesting IP address, make of browser used, and the URI of the form page. Web log files are cyclically deleted after nine weeks.
- b. The form processing is logged separately in another file, giving date, time, IP address, form name, the process followed (eg validation, if any, sending of email notification) and the fields of the questionnaire with their values as supplied by the respondents. This data is also kept for nine weeks after which time it is deleted.
- c. The form data itself is also recorded in a reprocessible format (XML) in case it needs to be reproduced as a form or table, rather than just a log of the transaction. This is kept permanently in the Computer Centre.

In practical terms, this all happens within 1-2 seconds of the form being submitted. At this stage a copy of the data is sent to the address of the person who handles the data for the client at HFRG.

Direct access is available to the Manager of the Computer Centre Electronic Publishing Unit and his staff. Systems Security and Operations staff also have access, as they have administrative rights on the web server.

All web site owners using the UCC Computer Centre server can see the server log files (a, above) because they need to be able to extract their own site data for analysis. Note these files do not contain any data provided by respondents to the questionnaires.

All web site owners could see the existence of (b) and (c) log files if they knew where to find them, but they would be unable to see the contents.

Normal browser users of the UCC web site cannot see any logs of any kind, as they are in directories that are not accessible to browsers.

Only Computer Centre staff in the Electronic Publishing Unit, Operations staff, and System Engineering staff would know where to find form data arriving from WAMMI and SUMI questionnaires. At the discretion of the Head of the Computer Bureau, this information could theoretically be made available to other Computer Centre staff; but is not, in usual practice.

Once the form data reaches the HFRG it is seen by the staff member assigned to the client requesting the questionnaire service. Originating URI information is stripped when the data is loaded into tables and compiled into reports.

Once the report has been generated for the client, client information, and information from questions other than the main SUMI and WAMMI questions is stripped, so that all that remains is the numeric data provided in response to each question. This is kept indefinitely at HFRG. It is impossible to deduce either the identity of the client, or of any particular respondent, from the retained data.

## 2.7 Permission of Study



Main Street,  
Templetuohy,  
Thurles,  
Co. Tipperary.  
9/8/2015

Ms Claire Donnelly,  
Physiotherapy Manager,  
Midlands Regional Hospital Tullamore,  
Co. Offaly.

Dear Claire,

I am writing to inform you of my intention to undertake a MSc. Research project in Midlands Regional Hospital, Tullamore as part of my taught MSc in Neurology and Gerontology from RCSI.

The title of my research project is "Assessing the usability of an electronic tablet application in vestibular rehabilitation". This will involve training subjects with complaints of dizziness, how to use a particular tablet application for adaptation or gaze stability exercises and then assessing how user-friendly the application is through questionnaires and an interview.

Subjects will be recruited from the vestibular out-patient clinic and from physiotherapy patients in out-patients, orthopaedic and medical wards. I would ask that the treating physiotherapists refer each dizzy patient in their practice onto me and act as a gatekeeper by giving the patient the information leaflets about the study. All ethical considerations will be followed and each patient will have the right to refuse to participate. This will not affect their treatment and I will continue to treat their dizziness or make the appropriate referral for their diagnosis.

It is hoped to recruit two patients per week which would result in two hours of onsite contact between me and subjects each week. These two hours can be completed outside my hours of contract as a staff grade physiotherapist in the department.

I understand I am asking a lot of the physiotherapists however it would hugely help in the promotion of the role of physiotherapy in dizziness within the hospital itself.

I would be most grateful if you could reply in writing with your approval or disapproval of the study.

Please do not hesitate to contact me with any queries.

Yours sincerely,

---

Patricia Hassett



## 2.8 Physiotherapy Manager Approval



Feidhmeannacht na Seirbhíse Sláinte  
Health Service Executive

Claire Donnelly

Physiotherapy Manager

Midlands Regional Hospital at Tullamore

Arden Rd

Tullamore

Co. Offaly

10 August 2015

To Whom it Concerns

As the Physiotherapy Manager for the Midland Regional Hospital at Tullamore, I am fully supportive of Patricia Hassett's research proposal; "Assessing the usability of an electronic tablet application in vestibular rehabilitation".

Vestibular Rehabilitation is an emerging field of physiotherapy and requires further study. This study investigates novel ways of delivering treatment to the client which should be encouraged and promoted.

I am confident that Patricia will carry out her research in an ethical manner as outlined in her application and I am happy to give her any assistance that is required.

Yours faithfully

Claire Donnelly

Physiotherapy Manager

## 2.9 Ethical Application

# STANDARD APPLICATION FORM

For the Ethical Review of  
Health-Related Research Studies, which  
are not Clinical Trials of Medicinal  
Products For Human Use  
as defined in S.I. 190/2004

DO NOT COMPLETE THIS APPLICATION FORM  
IF YOUR STUDY IS A CLINICAL TRIAL OF A MEDICINAL PRODUCT

Title of Study: The Assessment of the Usability of an Electronic Tablet  
Application for Vestibular Rehabilitation

Application Version No: 1

Application Date: 12/08/2015

For Official Use Only – Date Stamp of Receipt by REC:

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This Application Form is divided into Sections.

**\*Sections A, B, C, D, E, J and K are Mandatory.**

(Sections F, G, H, I and L are optional. Please delete Sections F, G, H, I and L if these sections do not apply to the application being submitted for review.)

**IMPORTANT NOTE:** Please refer to **Section I** within the form before any attempt to complete the Standard Application Form. **Section I** is designed to assist applicants in ascertaining if their research study is in fact a clinical trial of a medicinal product.

**IMPORTANT NOTE:** This application form permits the applicant to delete individual questions within each section depending on their response to the preceding questions. Please respond to each question carefully and refer to the accompanying *Guidance Manual* for more in-depth advice prior to deleting any question.

**PLEASE ENSURE TO REFER TO THE ACCOMPANYING GUIDANCE MANUAL  
WHEN COMPLETING THIS APPLICATION FORM.**

### SECTION A GENERAL INFORMATION

**SECTION A IS MANDATORY**

**A1 TITLE OF THE RESEARCH STUDY:**

The assessment of the usability of an electronic tablet application for vestibular rehabilitation

**A2 (a) Is this a multi-site study?**

IF YOU CHOSE 'YES' PLEASE DELETE QUESTIONS A2 (E) AND (F), IF YOU CHOSE 'NO' PLEASE  
DELETE QUESTIONS A2 (B) (C) AND (D)

**A2 (e) If no, please name the principal investigator with overall responsibility for the conduct of this single-site study.**

**Title:**

**Name:** Patricia Hassett

**Qualifications:** BSc Physiotherapy

**Position:** Staff Grade Physiotherapist

**Dept:** Rehabilitation

**Organisation:** Health Service Executive, Midlands Regional Hospital Tullamore

**Address:** Midlands Regional Hospital, Tullamore, Co. Offaly

**TEL:** 0860701358 **E-MAIL:** patriciahassett@rcsi.ie

**A2 (f) For single-site studies, please name the only site where this study will take place.**

Midlands Regional Hospital, Tullamore

**A3. DETAILS OF CO-INVESTIGATORS:**

**NAME OF SITE (IF APPLICABLE):** Royal College of Surgeons, Ireland (RCSI)

**Title:**

**Name:** Dara Meldrum

**QUALIFICATIONS:** BSc., MSc., PhD Physiotherapy

**POSITION:** Lecturer RCSI

**Dept :** Physiotherapy

**ORGANISATION:** N/A

**Address:** School of Physiotherapy, RCSI, 123 St Stephens Green, Dublin 2

**TEL:** 01 4022368 **E-MAIL:** dmeldrum@rcsi.ie

**ROLE IN RESEARCH E.G. STATISTICAL / DATA / LABORATORY**

**ANALYSIS:** Academic Supervisor

**A4. Lead contact person who is to receive correspondence in relation to this application or be contacted with queries about this application.**

**Name:** Patricia Hassett

**POSITION:** Physiotherapist and Principal Investigator

**ORGANISATION:** Midlands Regional Hospital, Tullamore

**Address for Correspondence:** Main St., Templetuohy, Thurles, Co. Tipperary

**TEL (WORK):** 057  
patriciahassett@rcsi.ie

**TEL (MOB.):** 0860701358 **E-MAIL:**

**A5 (A) IS THIS STUDY BEING UNDERTAKEN AS PART OF AN ACADEMIC QUALIFICATION?** ☒ Yes

If answer is No, please delete remaining questions in Section A

**A5 (b) IF YES, please complete the following:**

**Student Name(s):** Patricia Hassett

**Academic Course:** MSc. Neurology and Gerontology

**Academic Institution:** Royal College of Surgeons, Ireland

**A5 (c) Academic Supervisor(s):**

**Title:**

**Name:** Dara Meldrum

**Qualifications:** BSc. Physiotherapy, MSc, PhD

**Position:** Lecturer RCSI

**Dept:** Physiotherapy

**Organisation:** RCSI

**Address:** School of Physiotherapy, RCSI, 123 St Stephens Green, Dublin 2

**TEL:** 01 4022368 **E-MAIL:** dmeldrum@rcsi.ie

## SECTION B STUDY DESCRIPTORS

### SECTION B IS MANDATORY

**B1. What is the anticipated start date of this study?**

Once ethical approval has been received testing will begin 5/10/2015

**B2. What is the anticipated duration of this study?**

Testing will be ongoing from 5/10/15 until 31/12/2015 with write up between January 2016 and April 2016. This allows for 9 months duration from the ethics application

**B3. Please provide a brief lay (plain English) description of the study. Please ensure the language used in your answer is at a level suitable for use in a research participant information leaflet.**

This study is taking place in order to see how user-friendly a smartphone application is in the treatment of dizziness. Dizziness can be caused by an inner ear condition, a neurological disorder (where the brain or spinal cord are affected) or as a result of aging. The smartphone "app" will involve exercises for eye movement that aim to improve how well you can focus your vision when your head is moving. These exercises are called gaze stability or adaptation

exercises. This study is taking place in order to see if patients can use this “app” in place of their usual paper based gaze stability exercises. Each participant will be given a tablet with the “app” and asked to complete these exercises for one week. They will then return the tablet to the physiotherapist and complete 2 questionnaires and an interview with the physiotherapist to see how user friendly they found the tablet.

#### **B4. Provide brief information on the study background.**

The idea for this study came from the popularity of smartphone and tablet usage. The latest Eircom survey (2015) showed that 50% of Irish people own a smartphone with 1.2 million people expected to own a tablet by the end of 2015. Similarly, about 15% of adults complain of dizziness (Wiltink et al, 2009) however this number can rise to over 35% (Gopinath et al, 2009). Adults over 65 years also demonstrate an increased prevalence of dizziness with 36% of the elderly complaining of dizziness and imbalance (Jönsson et al, 2004).

Herdman et al (2003) found that adaptation exercises decrease symptoms of dizziness, increase postural stability and gaze stability in patients with chronic vestibular hypofunction. Original gaze stability exercises involve head movement with the eyes focused on a stable target. Using a tablet for these exercises instead of the usual piece of paper with a character on it, allows for easy progression of the exercises (by changing the backgrounds) and the ability of the therapist to know exactly how compliant their patient has been with their exercises.

Hornbaeck (2006) described the importance of usability testing as it allows for any corrections to be made to the software before the effect of it is tested.

This current study will show whether patients are interested in using technology with their rehabilitation and whether they find the application user friendly.

Recent studies such as Meldrum et al (2011) suggest that patients prefer technology to usual physiotherapy treatment as they reported higher levels of enjoyment and motivation. This highlights the need for physiotherapists to incorporate technology into their treatment regimes however; usability of this technology must be tested first to ensure its suitability for the patient.

#### **References:**

[http://pressroom.eircom.net/press\\_releases/article/ireland\\_-\\_a\\_tech\\_savvy\\_nation\\_that\\_needs\\_to\\_be\\_constantly\\_connected/](http://pressroom.eircom.net/press_releases/article/ireland_-_a_tech_savvy_nation_that_needs_to_be_constantly_connected/) Accessed 01/05/2015

Gopinath B., McMahon C. M., Roachchina E., Mitchell P. (2009) Dizziness and vertigo in an older population: the Blue Mountains prospective cross-sectional study *Clinical Otolaryngology* 34(6): 552-556

Herdman, S. J., Schubert, M. C., Das, V. E., & Tusa, R. J. (2003). Recovery of dynamic visual acuity in unilateral vestibular hypofunction. *Archives of Otolaryngology-Head & Neck Surgery*, 129(8), 819-824.

Hornbaek K. (2006) Current practice in measuring usability: Challenges to usability studies and research *International Journal of Human-Computer Studies* 64: 79-102

Jönsson R., Sixt E., Landahl S., Rosenhall U. (2004) Prevalence of dizziness and vertigo in an urban elderly population *Journal of Vestibular Rehabilitation* 14(1): 47-52

Meldrum D., Glennon A., Herdman S., Murray D., McConn-Walsh R. (2011) Virtual reality rehabilitation of balance: assessment of the usability of the Nintendo Wii® Fit Plus *Disability and Rehabilitation: Assistive Technology* 1–6

Wiltink J., Tschan R., Michal M., Subic-Wrana C., Eckhardt-Henn A., Dieterich M., Beutel M. E. (2009) Dizziness: Anxiety, health care utilization and health behaviour: Results from a representative German community survey *Journal of Psychosomatic Research* 66(5): 417-424



**B5. List the study aims and objectives.**

The aim of this study is to assess how “user-friendly” the vestibular rehabilitation application is for patients with central and peripheral vestibular hypofunction along with elderly patients complaining of dizziness. The usability of a new product such as an application should be tested prior to assessing the effectiveness of the application. The ability of the patients to use the application is paramount to the effectiveness of it as an intervention; therefore it is essential to carry out a usability study with this application before it is used as a treatment option. Usability is being assessed under three main heading of effectiveness, efficiency and satisfaction as recommended by the International Standardisation Organisation (ISO) in 1998.

The objectives of the study are to report each of the findings under those three headings. Effectiveness examines the accuracy and completeness with which users achieve certain goals. Indicators of effectiveness include the quality of the end user’s (study subject) solution and the amount of errors they make with the application. The objective here is to identify how good the subjects are at using the application. This will be achieved through the qualitative interview post intervention.

Efficiency is another objective of the study which examines the relationship between the accuracy and completeness with which users achieve certain goals and the resources expended in achieving them. Indicators of efficiency include task completion time and learning time. This will be assessed through the qualitative interview post intervention and timing each subject during their training session with the tablet.

The final objective is satisfaction. This looks at the user’s comfort with and positive attitude towards the use of the application. This will be assessed both qualitatively and quantitatively.

**B6. List the study endpoints / measurable outcomes (if applicable).**

Quantitative data in the study includes the time for each subject spent on training. This will be compared to their age. Other quantitative outcome measures include the System Usability Scale (SUS) and the Software Usability Measurement Inventory (SUMI). The SUS will assess the overall satisfaction level while the SUMI scale will assess efficiency, affect, helpfulness, controllability and learnability along with an overall score for satisfaction. While all areas of usability are assessed by these two outcome measures, satisfaction, efficiency and effectiveness will also be assessed through a qualitative interview to gain deeper insight.

**B7. Provide information on the study design.**

This study is an applied clinical study. It is also a cross sectional prospective observational study. It is not analysing the effect of an intervention, it is merely observing the ability of patients to use a particular rehabilitation technique and gaining their opinions and insights after their use. It is also a mixed methods study approach with both quantitative and qualitative components.

**B8. Provide information on the study methodology.**



The subject will begin using the tablet on their third physiotherapy session. This is to ensure that they are confident with their conventional gaze stability exercises before progressing to the tablet exercises.

The study will involve a baseline assessment of each participant to get an overall view of their current level of impairment. Baseline assessments will be carried out by the Principal Investigator (PI) and will include age and a visual analogue scale (VAS) for dizziness which is a valid tool for measuring a characteristic or attitude that is believed to range across a continuum of values and cannot easily be directly measured (Wewers & Lowe, 1990). Baseline assessments will also include the Dizziness Handicap Inventory. This is a validated 25-item questionnaire that scores the subject between zero and 100. It is used for the evaluation of problems as a result of dizziness. A higher DHI score indicates a greater level of handicap (Jacobson and Newman, 1990; Enloe and Shields, 1997).

Once these measures have been assessed the subject will then participate in semi structured training in the use of the tablet application. This training will be scripted (Enclosed) but will allow questions to be asked at any stage during it. The training will be timed on a stopwatch from the first sentence of the script ("This is the tablet you will be using") and will be stopped once all questions have been answered at the end ("Any further questions?"). This time will be recorded for each subject as a measure of their efficiency, one of the usability measures.

Once training is completed the subject is advised to continue using the application for one week instead of their usual gaze stability exercises. The subject is advised to continue the exercises three times per day for the seven days with a log of the completed exercises kept on the subject's profile on the application. An appointment will be made for one week's time where the subject will return the tablet and complete the questionnaires and interview. The questionnaires include the SUMI scale which has been validated by Sweeney and Maguire (1994) while Coleman (1993) found that the SUMI greatly improves novices' ability to provide specific design recommendations while also improving experts' ability, but to a lesser extent.

The SUS scale (Enclosed) is a Likert scale which has been validated by Bangor et al (2008) and Lewis and Sauro (2009) is a simple, ten-item scale giving a global view of subjective assessments of usability. The SUMI Scale (Enclosed) consists of 50 questions which can be answered either "Agree", "Undecided" or "Disagree" with Preece et al (1994) recommending SUMI as a standard method for assessing user attitudes. Once these questionnaires are completed a semi structured interview will take place between the subject and the PI (Enclosed).

Standardisation will be ensured by following the provided script for training and the adhering to the prompts provided in the interview. The PI will be assessing

the subjects pre and post use of the tablets ensuring that inter rater reliability will not be an issue.

The study will take place in the physiotherapy department of Midlands Regional Hospital, Tullamore for the vestibular subjects, and at the patient's bedside if they are an in-patient. Should the in-patients be discharged within the week, they may still take the tablet home with them as the out-patients will. They can then return the tablet after their week with it as an out-patient. All subjects will be treated in sitting.

The tablets used will be Samsung Galaxy Note 10.1 with Android Version 4.2 or later. These tablets are currently being used in another study on the Vestibular Rehabilitation Application and will be ready for use by the time of testing in this study. The application allows for several users at one time therefore each subject will log in with their coded name and invent their own password for the application. This password will also be known and recorded by the PI to allow for data collection from the application after the use of it. Should the subject have their own tablet, the application can be placed on their tablet. The PI will familiarise herself with this tablet and can adjust the script accordingly before beginning the training session with the subject. The subject will still log in to the application using their coded name.

**B9. Provide information on the statistical approach to be used in the analysis of your results (if appropriate) / source of any statistical advice.**

All coded data (with the PI being the only holder of the key for the code) will be entered onto a Microsoft Excel Spreadsheet and Stata11 (StatCorpLP) will be used for statistical analysis. Spearman's Rank Order Correlation will be used to investigate association between the SUS and age and DHI. The SUMI data is analysed by a programme called SUMISCO. The current version of SUMISCO works with Microsoft Windows 3.1. SUMISCO carries out all the scoring activities discussed above automatically, and enables export of files which can quickly become evaluation reports to word processors and scored data files to spreadsheets and more sophisticated statistical programs. The raw question data is coded, combined and transformed into a global subscale and five additional subscales of efficiency, affect, helpfulness, controllability and learnability. This data is entered online and sent to the Human Factors Research Group (HFRG) at University College Cork for analysis. An ethics statement regarding data protection is available (enclosed) however the data that is sent to UCC will be coded with the PI being the only holder of the key to the code.

The PI will use thematic analysis to analyse the interview answers and code the responses. High frequencies of a key word will be given a theme.

**B10 (a) Please justify the proposed sample size and provide details of its calculation (including minimum clinically important difference).**

The sampling method is by convenience and a sample size of at least 12 participants has been calculated as necessary to obtain sufficient data on the System Usability Scale (SUS) (Brooke, 1996) and the paper version of the Software Usability Measurement Inventory (SUMI) (Kirakowski, 1993). As no other research on usability of applications has been carried out previously, the author was unable to calculate the minimally clinical important difference.

**B10 (b) Where sample size calculation is impossible (e.g. it is a pilot study and previous studies cannot be used to provide the required estimates) then please explain why the sample size to be used has been chosen.**

Lewis et al (2009) recommend a sample of 12 is sufficient for the SUS while Kirakowski (1993) suggests that 12 participants are necessary for the paper version of SUMI

**B11. How many research participants are to be recruited in total?**

Allowing for two subjects per week to be recruited, the study aims to have 24 participants

**B12 (a) How many research participants are to be recruited in each study group (where applicable)? Please complete the following table (where applicable).**

Name of Study Group:
Tablet Application Group
Number of Participants in this Study Group:
24

**B12 (b) Please provide details on the method of randomisation (where applicable).**

There will be no randomisation. Sampling will be done by convenience

**B13. How many research participants are to be recruited at each study site (where applicable)? Please complete the following table.**

<b>Site:</b>	<b>Number of Research Participants at this site:</b>
MIDLANDS REGIONAL HOSPITAL TULLAMORE	24

## SECTION C study PARTICIPANTS

SECTION C IS MANDATORY

### C1 PARTICIPANTS – SELECTION AND RECRUITMENT

#### C1.1 How will the participants in the study be selected?

The population includes patients with diagnosed vestibular hypofunction including both central and peripheral dizziness. The population also includes adults over 65 years of age who are complaining of dizziness. The sample in the study includes those that have been referred for vestibular rehabilitation.

#### C1.2 How will the participants in the study be recruited?

Subjects will be recruited from the vestibular clinic, the orthopaedic ward and the medical wards in Midlands Regional Hospital, Tullamore and community physiotherapy departments in Birr and Edenderry, Co. Offaly. The subjects must have been referred to vestibular rehabilitation for VOR retraining and will be selected by convenience. There will be no randomisation of the participants. The gatekeepers will be an advanced nurse practitioner in the vestibular clinic who tests the patients before referral to physiotherapy and the treating physiotherapist on the medical and orthopaedic wards and in Birr or Edenderry community physiotherapy settings. They will inform the patient about the study and give them the patient information and invitation leaflets and gain informed written consent. Should the patient refuse to participate, they will still be referred from vestibular rehabilitation and this will not affect their treatment.

#### C1.3 What are the inclusion criteria for research participants? (Please justify, where necessary)

Inclusion Criteria include:

- Subjects referred for vestibular rehabilitation in Midlands Regional Hospital, Tullamore
- Subjects must be 18 years or older
- Subjects must have normal comprehension as judged by their treating physiotherapist or vestibular nurse and must be able to follow instruction. If a formal assessment is required, the Montreal Cognitive Assessment (MoCA) will be carried out. Those with a score of 26 or more can participate in the study.

- Subjects must be about to begin, have started, currently participate in or have completed a vestibular rehabilitation programme
- Must have quantified peripheral or central vestibular hypofunction as diagnosed by an audiologist including but not exhaustive of:

- Unilateral or bilateral vestibular hypofunction
- Acoustic neuroma resections
- Unilateral Meniere's disease
- Vestibular neuritis
- Migraine related vestibulopathy and dizziness
- Multiple Sclerosis
- Post stroke dizziness

or any complaint of dizziness with head movement.

#### **C1.4 What are the exclusion criteria for research participants? (Please justify, where necessary)**

Exclusion criteria include:

- Subjects with an active benign paroxysmal positional vertigo (BPPV)
- Subjects that are unable to follow instruction or with a MoCA of less than 26. Those with less than 26 will be treated with usual vestibular rehabilitation exercises.

#### **C1.5 Will any participants recruited to this research study be simultaneously involved in any other research project?** Not to my knowledge

## **C2 PARTICIPANTS – INFORMED CONSENT**

### **C2.1 (a) Will informed consent be obtained?** Yes

### **C2.1 (c) If yes, please outline the consent process in full. (How will consent be obtained, when, by whom and from whom etc.)**

The treating physiotherapist on the ward or in the community or the vestibular nurse in the vestibular clinic will initially approach the suitable patient and describe the study to the patient and will give them the patient information and invitation leaflets and the informed written consent form. It will be clear from the patient information leaflet and from explaining it to the subject that it is voluntary to participate in the study and they have the right to refuse to participate or to drop out without giving reason at any stage during the study.

The PI will also be available to answer any question before written consent is gained.

**C2.2 (a) Will participants be informed of their right to refuse to participate and their right to withdraw from this research study?**

Yes. This will not affect their treatment in anyway, they will continue with their usual vestibular rehabilitation

**C2.3 (a) Will there be a time interval between giving information and seeking consent?**

**C2.3 (b) If yes, please elaborate.**

The vestibular nurse or treating physiotherapist on the ward or in the community will initially approach the patient with the idea. The patient must give informed written consent to the gatekeeper, preferably on the same day. However they will have time to read the information leaflet without the gatekeeper present and also raise any concerns with the PI if required.

**C3 adult participants (AGED 18 or over) - CAPACITY**

**C3.1 (a) Will all adult research participants have the capacity to give informed consent?**

If answer is Yes, please delete remaining questions in Section C3

**c4 participants under the age of 18**

**C4.1 (a) Will any research participants be under the age of 18 i.e. Children?**

If answer is No, please delete remaining questions in Section C4

**C5 PARTICIPANTS - CHECKLIST**

**C5.1 Please confirm if persons from any of the following groups will participate in this study. This is a quick checklist to assist research ethics committee members and to identify whether study participants include persons from vulnerable groups and to establish what special arrangements, if any, have been made to deal with issues of consent. It is recognised that not all groups in this listing will automatically be vulnerable or lacking in capacity. Please refer to the HSE's National Consent Policy, particularly Part 3, Section 5.**

**Committees are particularly interested to know if persons in any of these groups are being targeted for inclusion, as per the inclusion criteria.**

**(a) Healthy Volunteers**

**(b) Patients**

- **Unconscious patients**
- **Current psychiatric in-patients**
- **Patients in an emergency medical setting**

**(c) Relatives / Carers of patients**

**(d) Persons in dependent or unequal relationships**

- **Students**
- **Employees / staff members**
- **Persons in residential care**
- **Persons highly dependent on medical care**

**(e) Intellectually impaired persons**

**(f) Persons with a life-limiting condition**

*(Please refer to guidance manual for definition)*

**(g) Persons with an acquired brain injury**

**C5.2 If yes to any of the above, please comment on the vulnerability of the research participants, and outline the special arrangements in recognition of this vulnerability (if any).**

The treating physiotherapists/nurse will judge as to whether the participant can give informed consent. If they can and have the physical ability to use a tablet, they can be included in the study. If the participant has cognitive issues and is unable to give informed consent and cannot independently use an electronic tablet, they will be excluded from the study and their vestibular treatment will continue as usual.

**C5.3 Please comment on whether women of child-bearing potential, breastfeeding mothers, or pregnant women will be included or excluded in this research study.**

Should a pregnant woman present with dizziness (exclusive of active BPPV), she will be included in the study

## SECTION D research PROCEDURES

### SECTION D IS MANDATORY

**D1 (A) What activities, procedures or interventions (if any) are research participants asked to undergo or engage in for the purposes of this research study?**

Outside of routine care the participant will undergo training for the use of the electronic tablet application, they will then use the tablet instead of their original gaze stability exercises for one week and on their return to the PI, they will undergo an interview and complete both the SUMI scale and SUS.

**D1 (B) WHAT OTHER ACTIVITIES (IF ANY) ARE TAKING PLACE FOR THE PURPOSES OF THIS RESEARCH STUDY E.G. CHART REVIEW, SAMPLE ANALYSIS ETC?**

N/A

**D2. Please provide details below of any potential harm that may result from any of the activities, procedures, interventions or other activities listed above.**

The patient may experience dizziness and Oscillopsia (blurred vision with head movement) with their gaze stability exercises. These exercises work on the premise of provoking the patient's dizziness symptoms and it is anticipated that by week three of their vestibular rehabilitation programme the participant will be aware of the dizziness caused by these exercises

**D3. What is the potential benefit that may occur as a result of this study?**

These exercises are designed to improve gaze stability therefore it is anticipated that the subject will have improved visual acuity with head movement

**D4 (A) WILL THE STUDY INVOLVE THE WITHHOLDING OF TREATMENT?**

NO , THE PARTICIPANTS WILL MERELY SWAP THEIR ORIGINAL GAZE STABILITY EXERCISES FROM A PAPER VERSION TO THE TABLET VERSION. THE EXERCISES WILL REMAIN THE SAME, THEY WILL JUST BE ON A DIFFERENT FORMAT

**D5 (A) HOW WILL THE HEALTH OF PARTICIPANTS BE MONITORED DURING THE STUDY, AND WHO WILL BE RESPONSIBLE FOR THIS?**

The general health of the participants on the wards will be monitored by reading their clinical notes and daily observations (blood pressure, oxygen saturations, heart rate etc as per the National Early Warning Score protocol) and by



subjectively assessing their general health. Similarly general health will be subjectively assessed for the out-patient participants. The PI will be responsible and should an issue arise, the participant's team or GP will be consulted

**D5 (B) HOW WILL THE HEALTH OF PARTICIPANTS BE MONITORED AFTER THE STUDY, AND WHO WILL BE RESPONSIBLE FOR THIS?**

The PI will be responsible for this. After the study the participant will still be attending the PI for their original vestibular rehabilitation. General health will be monitored as above and should an issue arise, again the relevant team or GP will be contacted

**D6 (A) WILL THE INTERVENTIONS PROVIDED DURING THE STUDY BE AVAILABLE IF NEEDED AFTER THE TERMINATION OF THE STUDY?**

**D7. PLEASE COMMENT ON HOW INDIVIDUAL RESULTS WILL BE MANAGED.**

Individual results will be given to the participant. It is unlikely to find a negative result with this type of study as it is mainly opinion-based, however should a negative finding arise, the appropriate referral to their consultant/GP will be made with the patient's consent. Should an incidental finding arise, the participant has the right to be provided with the option of whether they want this information disclosed to them. This will be indicated in the consent form

**D8. PLEASE COMMENT ON HOW AGGREGATED STUDY RESULTS WILL BE MADE AVAILABLE.**

It is anticipated that this study will be published in a peer-reviewed journal. All participants will have the option of knowing the overall results

**D9. WILL THE RESEARCH PARTICIPANT'S GENERAL PRACTITIONER BE INFORMED THAT THE RESEARCH PARTICIPANT IS TAKING PART IN THE STUDY (IF APPROPRIATE)?**

**D10. WILL THE RESEARCH PARTICIPANT'S HOSPITAL CONSULTANT BE INFORMED THAT THE RESEARCH PARTICIPANT IS TAKING PART IN THE STUDY (IF APPROPRIATE)?**

**SECTION E data protection**

**SECTION E IS MANDATORY**

**E1 data processing - consent**

**E1.1 (A) WILL CONSENT BE SOUGHT FOR THE PROCESSING OF DATA?**

## **E2 data processing - GENERAL**

### **E2.1 WHO WILL HAVE ACCESS TO THE DATA WHICH IS COLLECTED?**

The PI will have access to all data. Coded (by the PI) SUMI data will be sent to Human Factors Research Group for analysis

### **E2.2 WHAT MEDIA OF DATA WILL BE COLLECTED?**

Quantitative data will be originally on paper but this will be transferred to a common computerised data form (enclosed). Qualitative data will be audio originally but will be transcribed to a computerised document. Until the audio data is transcribed, it too be securely stored in a locked cabinet in the physiotherapy department in MRHT

### **E2.3 (A) WOULD YOU CLASS THE DATA COLLECTED IN THIS STUDY AS anonymous, irrevocably anonymised, pseudonymised, coded or identifiable data?**

Coded

### **E2.3 (B) IF 'CODED', PLEASE CONFIRM WHO WILL RETAIN THE 'KEY' TO RE-IDENTIFY THE DATA?**

The PI

### **E2.4 WHERE WILL DATA WHICH IS COLLECTED BE STORED?**

Data will be collected on the wards for in-patients or in the physiotherapy department for out-patients. Once both quantitative and qualitative data have been transferred to their computerised formats, they will be stored on a password protected USB key. All paper and audio versions will be destroyed by the PI. All written and computerised data will be securely stored on site in the physiotherapy department. Until the audio data is transcribed, it too be securely stored in a locked cabinet in the physiotherapy department in MRHT

### **E2.5 PLEASE COMMENT ON SECURITY MEASURES WHICH HAVE BEEN PUT IN PLACE TO ENSURE THE SECURITY OF COLLECTED DATA.**

Before the paper versions are destroyed they will be stored in a locked filing cabinet in the physiotherapy department on site. Once transferred to computerised format, they will be saved to a password protected USB key and again stored in a locked cabinet in the physiotherapy department on site. The PI will be the only person with access to the locked filing cabinet. The SUMI data being sent to the Human Factors Research group will be coded and will not be identifiable with only the PI holding the key to the code.

### **E2.6 (A) WILL DATA COLLECTED BE AT ANY STAGE LEAVING THE SITE(S) OF ORIGIN?**

YES

**E2.6 (B) IF YES, PLEASE ELABORATE.**

The SUMI questionnaire data will be sent to University College Cork for analysis. This data will be coded and will not be identifiable with only the PI holding the key to the code.

**E2.7 WHERE WILL DATA ANALYSIS TAKE PLACE AND WHO WILL PERFORM DATA ANALYSIS (IF KNOWN)?**

Analysis of the SUMI questionnaire, which will be coded data and non-identifiable, will take place in University College Cork by the Human Factors Research Group. All other analysis will take place in the physiotherapy department in MRHT by the PI

**E2.8 (A) AFTER DATA ANALYSIS HAS TAKEN PLACE, WILL DATA BE DESTROYED OR RETAINED?**

Retained

**E2.8 (B) PLEASE ELABORATE.**

The computerised data will be retained for future publication

**E2.8 (D) IF RETAINED, FOR HOW LONG, FOR WHAT PURPOSE, AND WHERE WILL IT BE RETAINED?**

The coded and non-identifiable data will be retained for long enough to allow publication of it. It will be stored in Royal College of Surgeons, Ireland as is protocol with the college.

**E2.9 PLEASE COMMENT ON THE CONFIDENTIALITY OF COLLECTED DATA.**

All data will be coded with only the PI in possession of the key therefore any disclosure of data to third parties will be non-identifiable

**E2.10 (A) WILL ANY OF THE INTERVIEW DATA COLLECTED CONSIST OF AUDIO RECORDINGS / VIDEO RECORDINGS?** YES

**E2.10 (B) IF YES, WILL PARTICIPANTS BE GIVEN THE OPPORTUNITY TO REVIEW AND AMEND TRANSCRIPTS OF THE TAPES?**

Yes. This is mentioned in the consent form and will be suggested by the PI after the interview

**E2.11 (A) WILL ANY OF THE STUDY DATA COLLECTED CONSIST OF PHOTOGRAPHS/ VIDEO RECORDINGS?** NO

## e3 ACCESS TO HEALTHCARE RECORDS

**E3.1 (A) DOES THE STUDY INVOLVE ACCESS TO HEALTHCARE RECORDS (HARD COPY / ELECTRONIC)?** ☒ YES

If answer is No, please delete remaining questions in Section E3

**E3.1 (B) IF YES, PLEASE ELABORATE.**

Patient medical hard copy charts will be accessed for the patient's age and diagnosis of the cause of his/her dizziness if there is a known cause.

**E3.1 (C) WHO WILL ACCESS THESE HEALTHCARE RECORDS?**

The PI will access the charts for study purposes and will also use them to document their vestibular rehabilitation (prior to the study commencement). The charts will also be in use by the gatekeepers as part of their routine treatment in order to write their notes

**E3.1 (D) WILL CONSENT BE SOUGHT FROM PATIENTS FOR RESEARCH TEAM MEMBERS TO ACCESS THEIR HEALTHCARE RECORDS?** ☒ YES

If answer is Yes, please delete remaining questions in Section E3

## SECTION f HUMAN BIOLOGICAL MATERIAL

### f1 Bodily Tissue / Bodily Fluid Samples - general

**F1 1 (a) Does this study involve human biological material?** ☐ NO

If the answer is No, please delete Section F

### section G radiation

#### G1 radiation – general

**G1.1 (a) Does this study/trial involve exposure to radiation?** ☐ NO

If answer is No, please delete remaining questions in Section G

## SECTION H MEDICAL DEVICES

**H1 (A) IS THE FOCUS OF THIS STUDY/TRIAL TO INVESTIGATE/EVALUATE A MEDICAL DEVICE?**

If answer is No, please delete remaining questions in Section H.

## **SECTION I MEDICINAL PRODUCTS / COSMETICS / FOOD AND FOODSTUFFS**

### **I.1 NON-INTERVENTIONAL TRIALS OF MEDICINAL PRODUCTS**

**I1.1 (a) Does this study involve a medicinal product?**

If the answer is No, please delete remaining questions in subsection I1

### **I.2 COSMETICS**

**I2.1 (a) Does this study involve a cosmetic?**

If the answer is No, please delete remaining questions in subsection I2

### **I.3 FOOD AND FOOD SUPPLEMENTS**

**I3.1 (a) Does this study involve food or food supplements?**

If the answer is No, please delete remaining questions in subsection I3

## **SECTION j INDEMNITY and insurance**

**SECTION J IS MANDATORY**

**J1 PLEASE CONFIRM AND PROVIDE EVIDENCE THAT APPROPRIATE INSURANCE/INDEMNITY IS IN PLACE FOR THIS RESEARCH STUDY AT EACH SITE.**

The PI is covered by her own professional indemnity insurance and by the Clinical Indemnity Scheme under the HSE
--

**J2 PLEASE CONFIRM AND PROVIDE EVIDENCE THAT APPROPRIATE INSURANCE/INDEMNITY IS IN PLACE FOR THIS RESEARCH STUDY FOR EACH INVESTIGATOR.**

As above
----------

**J3.1 Please give the name and address of the organisation / or individual legally responsible for this research study?**

Patricia Hassett, Main Street, Templetuohy, Thurles, Co. Tipperary

**J3.3 PLEASE CONFIRM AND PROVIDE EVIDENCE OF ANY SPECIFIC ADDITIONAL INSURANCE / INDEMNITY ARRANGEMENTS WHICH HAVE BEEN PUT IN PLACE, IF ANY, BY THIS ORGANISATION / OR INDIVIDUAL FOR THIS RESEARCH STUDY?**

N/A

## **SECTION k COST AND RESOURCE IMPLICATIONS, funding and payments**

**SECTION K IS MANDATORY**

### **k1 COST AND RESOURCE IMPLICATIONS**

**K1.1 PLEASE PROVIDE DETAILS OF ALL COST / RESOURCE IMPLICATIONS RELATED TO THIS STUDY (E.G. STAFF TIME, OFFICE USE, TELEPHONE / PRINTING COSTS ETC.)**

Item	Source	Cost
Paper	Lowcostoffice.ie	€4.25
Printer Ink Cartridge	Lowcostoffice.ie	€5.19
Printer	Self	€0
Dictaphone	Argos	€17.99
Sandisk Cruzer Blade USB Key	Harvey Norman	€16
Total		€43.43
Time Resources: Two participants per week = two hours (one hour on week one as there will be no participants returning) Total: 23 hours participant contact time		

### **k2 funding**

**K2.1 (a) Is funding in place to conduct this study?**

NO

**K2.1 (b) If no, has funding been sought to conduct this study? From where? Please elaborate.**

NO

**K2.1(e) Is the study funded by a 'for profit' organisation?** NO

**K2.2 (a) Do any conflicts of interest exist in relation to funding or potential funding?** NO

**K2.2 (b) If yes, please elaborate.**

N/A

### **k3 payments to investigators**

**K3.1 (a) Will any payments (monetary or otherwise) be made to investigators?** NO

**K3.1 (b) If yes, please provide details of payments (including amount).**

N/A

### **k4 payments to PARTICIPANTS**

**K4.1 (a) Will any payments / reimbursements (monetary or otherwise) be made to participants?** NO

**K4.1 (b) If yes, please provide details of payments / reimbursements (including amount).**

N/A

## **SECTION I additional ethical ISSUES**

**L1 (a) Does this project raise any additional ethical issues?** YES

If answer is No, please delete remaining questions in Section L.

**L1 (b) If yes, please identify any particular additional ethical issues that this project raises and discuss how you have addressed them.**

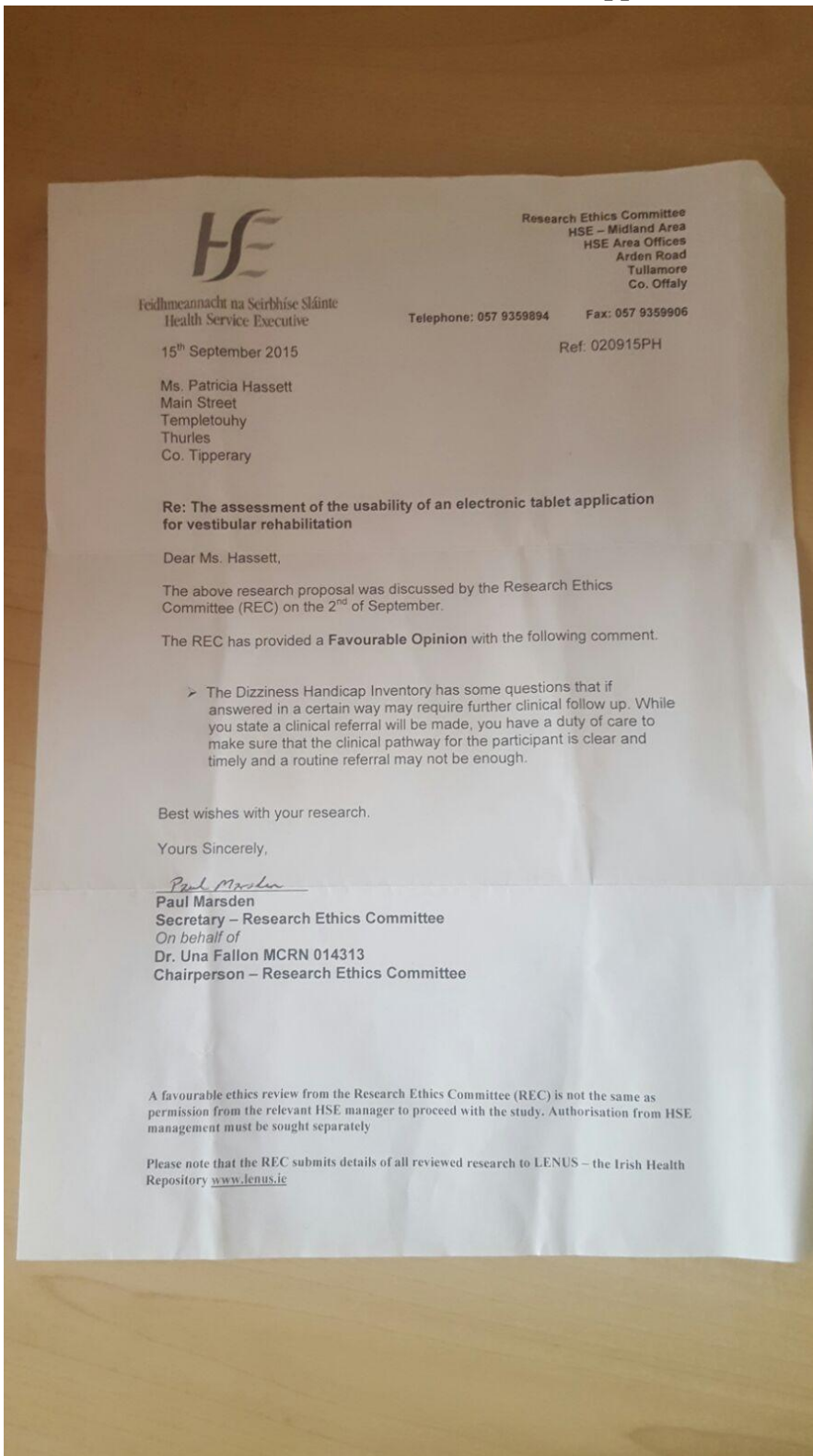
One of the ethical issues is the transfer of the SUMI questionnaire data from MRHT to UCC for analysis. However to overcome this barrier, all data sent to

UCC will coded. The Human Factors Research Group will be unable to identify any of the participants in the study from the data they receive. Another possible ethical issue is the idea that treatment will be withheld. This will not be the case in this study as participants will continue the same exercises and rehabilitation, just through a different medium. Their original exercises will be paper based, the exercises will remain the same for the study, they will merely be in tablet format.

PLEASE ENSURE THIS APPLICATION FORM IS FULLY COMPLETED AS INCOMPLETE SUBMISSIONS WILL NOT BE REVIEWED.



## 2.10 Tullamore Research Ethics Committee Approval



## 2.10 Royal College of Surgeons Ireland Ethical Approval

Royal College of Surgeons in Ireland  
The Research Ethics Committee  
121 St. Stephens Green, Dublin 2, Ireland.  
Tel: +353 1 4022205 Email: recadmin@rcsi.ie

Dr David Smith, Acting Chair  
Dr Niamh Clarke, Convenor

21<sup>st</sup> October 2015

Ms Patricia Hassett  
Physiotherapy Department  
Midlands Regional Hospital Tullamore  
Arden Road,  
Tullamore,  
Co. Offaly



Ethics Reference No:	1161 (Approval accepted from Research Ethics Committee of the HSE – Midland Area (Tullamore))
Project Title:	The assessment of the usability of an electronic tablet application for vestibular rehabilitation
Researchers Name (lead applicant):	Ms Patricia Hassett
Principal investigator on the project (PI):	Dr Dara Meldrum (academic supervisor, RCSI Dept of Physiotherapy)

Dear Ms Hassett,  
Thank you for your Research Ethics Committee (REC) application. Chairperson's approval has been granted for this study and the RCSI REC accepts the ethical approval granted by Research Ethics Committee of the HSE – Midland Area for the research study (details above) submitted by Ms Patricia Hassett.

Approval from the RCSI REC is granted on condition that Ms Hassett adheres to the request made by the Research Ethics Committee of the HSE – Midland Area regarding the issue of the researcher's duty of care.

This letter provides approval for data collection for the time requested in your application and for an additional 6 months. This is to allow for any unexpected delays in proceeding with data collection. Therefore this research ethics approval will expire on 26<sup>th</sup> July 2016.

Where data collection is necessary beyond this point, approval for an extension must be sought from the Research Ethics Committee.

This ethical approval is given on the understanding that:

- All personnel listed in the approved application have read, understand and are thoroughly familiar with all aspects of the study.
- Any significant change which occurs in connection with this study and/or which may alter its ethical consideration must be reported immediately to the REC, and an ethical amendment submitted where appropriate.
- Please submit a final report to the REC upon completion of your project.

We wish you all the best with your research.

Yours sincerely,

PP Dr Niamh Clarke (Convenor)  
Dr David Smith (Acting Chair)

## 2.11 ETDRS Eye Chart for DVAT

LOGARITHMIC VISUAL ACUITY CHART 1  
MODIFIED "ETDRS" FOR EUROPEAN-WIDE USE  
FOR TESTING AT 4 METERS

DECIMAL SNELLEN		LogMAR
1.0	E O H A M	1.0
0.8	T A X P E	0.9
0.6	M K E X B	0.8
0.5	K E B H X	0.7
0.4	A K P M E	0.6
0.32	H M O B K	0.5
0.25	B H T O X	0.4
0.2	K T M B H	0.3
0.16	H X K E P	0.2
0.125	X P M K O	0.1
0.1	P H O T A	0.0
0.08	M B X P O	-0.1
0.063	E A H K T	-0.2
0.05	O B A E K	-0.3

Precision Vision®  
 Manufactured by: La Salle, IL • U.S.A. • Phone 800-772-9211 • precision-vision.com

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 CAT. NO 2810

## **2.12 Equipment Loan Agreement Form**

### **Equipment Loan Agreement**

This agreement is between (insert owner) and (insert borrowing organisation).

Terms and Conditions of Loan 1. The owner will lend the equipment to the borrowing organisation on the terms and conditions of this agreement 2. The equipment shall be loaned from (insert date) until (insert date), the loan period 3. The loan period may be extended by mutual consent of both parties 4. No variation or amendment of this agreement will be effective unless it is made in writing, this can be by email

Collection and Delivery of Equipment 1. The borrower must arrange a mutually convenient time to collect the equipment on the first day of the loan period and to return it on the last day of the loan period

Payment 1. The equipment is to be loaned free of charge

Title and Risk 1. Title and all rights to the equipment shall at all times remain with the owner of the equipment. The borrowing organisation acknowledges that it has no right, title or property in the equipment 2. The owner will have the equipment checked to ensure it is fit for purpose prior to collection 3. Risk of any loss or damage to the equipment will become the responsibility of the borrowing organisation upon it leaving the owners possession and shall not revert back to the owner until the equipment is back on the owners premises 4. The borrowing organisation will ensure that the equipment to be borrowed is age appropriate to its intended audience

Cleanliness 1. The equipment should be appropriately cleaned prior to the loan period by the owner and following the loan period by the borrowing organisation to avoid risk of cross contamination

Owners Obligations 1. Provide the borrowing organisation with operating, maintenance and servicing instructions as appropriate 2. Provide the necessary information about training requirements for the correct use of the equipment 3. Ensure the equipment has undergone the checks detailed in 'Title and Risk' point 2

The borrowing organisations undertakings The organisation borrowing the equipment agrees that during the loan period it shall: 1. Keep the equipment in its possession and control and ensure that it is secure against loss, damage and theft 2. Operate the equipment in accordance with any operating instructions issued for it and for the purpose it was designed

3. Ensure that the equipment is used by an appropriately skilled and trained member of staff 4. Any required maintenance and repair of equipment shall be performed by approved personnel. Ensure that relevant Health and Safety regulations are met at all times 5. Keep the equipment in good working order, fair wear and tear excepted 6. Ensure that identification marks or labels on the equipment are not removed, defaced, amended, and obscured including those which identify the equipment as belonging to the owner 7. The equipment will not be modified without first obtaining the owners written approval

Insurance In the event of the equipment being lost or damaged: 1. The borrowing organisation agrees to pay the replacement cost as indicated below OR 2. The equipment is covered under the

owners insurance, the owner will ensure the equipment is covered for use off site OR 3. The borrowing organisation are required to take out additional insurance

Please state one of the above options:

Inventory of Equipment Please list all equipment being loaned and replacement costs where applicable.

Equipment on loan: Replacement cost:

Signed on behalf of (insert name of owner)

Signature.....Date.....

Print Name..... Position.....

Signed on behalf of (insert name of borrower)

Signature.....Date.....

Print Name..... Position.....

## 2.13 National Framework of Qualifications (NFQ)



## 2.14 Dizziness Handicap Inventory

### The Dizziness Handicap Inventory ( DHI )

P1. Does looking up increase your problem?	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No
E2. Because of your problem, do you feel frustrated?	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No
F3. Because of your problem, do you restrict your travel for business or recreation?	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No
P4. Does walking down the aisle of a supermarket increase your problems?	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No
F5. Because of your problem, do you have difficulty getting into or out of bed?	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No
F6. Does your problem significantly restrict your participation in social activities, such as going out to dinner, going to the movies, dancing, or going to parties?	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No
F7. Because of your problem, do you have difficulty reading?	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No
P8. Does performing more ambitious activities such as sports, dancing, household chores (sweeping or putting dishes away) increase your problems?	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No
E9. Because of your problem, are you afraid to leave your home without having someone accompany you?	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No
E10. Because of your problem have you been embarrassed in front of others?	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No
P11. Do quick movements of your head increase your problem?	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No
F12. Because of your problem, do you avoid heights?	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No
P13. Does turning over in bed increase your problem?	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No
F14. Because of your problem, is it difficult for you to do strenuous homework or yard work?	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No
E15. Because of your problem, are you afraid people may think you are intoxicated?	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No
F16. Because of your problem, is it difficult for you to go for a walk by yourself?	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No
P17. Does walking down a sidewalk increase your problem?	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No
E18. Because of your problem, is it difficult for you to concentrate	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No

F19. Because of your problem, is it difficult for you to walk around your house in the dark?	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No
E20. Because of your problem, are you afraid to stay home alone?	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No
E21. Because of your problem, do you feel handicapped?	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No
E22. Has the problem placed stress on your relationships with members of your family or friends?	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No
E23. Because of your problem, are you depressed?	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No
F24. Does your problem interfere with your job or household responsibilities?	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No
P25. Does bending over increase your problem?	<input type="radio"/> Yes <input type="radio"/> Sometimes <input type="radio"/> No

Used with permission from GP Jacobson.

Jacobson GP, Newman CW: The development of the Dizziness Handicap Inventory. *Arch Otolaryngol Head Neck Surg* 1990;116: 424-427

## DHI Scoring Instructions

The patient is asked to answer each question as it pertains to dizziness or unsteadiness problems, specifically considering their condition during the last month. Questions are designed to incorporate functional (F), physical (P), and emotional (E) impacts on disability.

To each item, the following scores can be assigned: No=0 Sometimes=2  
Yes=4

Scores:

Scores greater than 10 points should be referred to balance specialists for further evaluation.

16-34 Points (mild handicap), 36-52 Points (moderate handicap), 54+ Points (severe handicap)

## 2.15 Visual Analogue Scale for Dizziness

### Visual Analog Scale





## 2.16 Script for Training

### Script for Training

This is the training script for the Samsung Galaxy Note 10.1 Tablet (Source = PI)

#### Remember to start stopwatch on the first point

1. This is the tablet you will be using for your gaze stability exercises.
2. You can turn on the tablet by holding down this button (show subject the button and get subject to turn on the tablet)
3. You unlock the tablet by swiping across like so (demonstrate then lock the screen and get subject to repeat)
4. You will find the application for your exercises on the home screen. This icon with the house will always direct you to the home screen where your exercises are (show the icon and get subject to press it).
5. Tap the Vestibular Rehabilitation Application icon
6. This is where your exercises are. You will log in with the username \_\_\_\_\_ and password \_\_\_\_\_ (subject to fill in login details).
7. Tap the exercise icon
8. Tap the Day One, morning exercise #1.
9. Place the tablet here at eye level, tap the start icon and stand at this point 6 feet away
10. When the timer begins you may do your usual head rotation exercise, keeping your eyes focused on the letter E on the screen (Subject to complete exercise for one minute)
11. I want you to set up and do the next exercise by yourself (Subject to progress to morning exercise #2. Trainer is free to assist and answer questions as needed)
12. Once morning exercise #2 is completed: That's one round of exercises done. I want you to complete the rest of the exercises each day at home. Can you get back to the home screen of the tablet?
13. This is how you lock the tablet (demonstrate and get subject to repeat)
14. Is there anything you'd like to go over or have you any questions?
15. Once questions have been answered: This is the charger for the tablet. The amount of battery left is in the bottom right hand corner
16. No further questions?

#### Stop the stopwatch

## 2.17 Semi Structured Interview

### Interview post use of tablet application

Questions	Prompts	Measurement
1. What's your general use of technology?	Have you ever used an application before?	Background information
2. How did you find operating the application?	Did you find you were making many mistakes with it	Effectiveness
3. Roughly, how long did it take you to complete each bout of exercises?	At the start of the week? Middle of week? End of week?	Efficiency
4. Which exercises did you prefer; the application or original gaze exercises?	Why did you prefer this?	Satisfaction
5. Were you comfortable using the application?	Was there less/more dizziness than usual exercises?	Satisfaction
6. How compliant were you with the exercises on the app?	Did you complete all of the exercises daily? Were you more compliant with the app or the usual exercises	Exercise Adherence
7. What did you like about the application	What did you find helpful?	Satisfaction
8. What did you not like about the application?	Are there any barriers to using it in the future? Anything that would stop you from using the application?	Satisfaction

### 3.1 Previous Use of Technology

Technology	Previous Use
Smartphone	58.33% (n=7)
Tablet	50.00% (n=6)
Apps	58.33% (n=7)